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Related to the Silicate Industries

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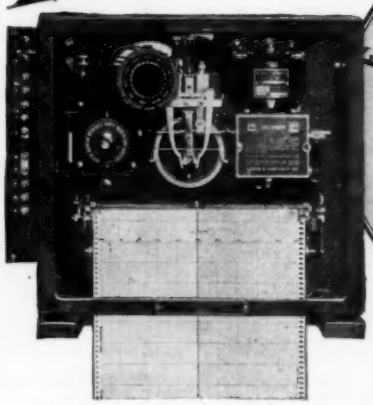

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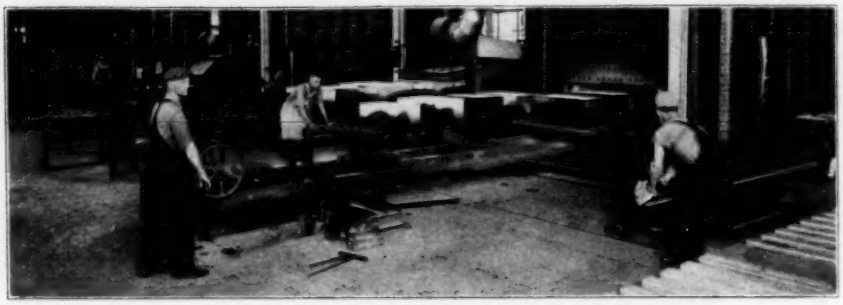

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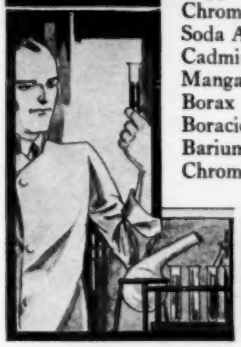

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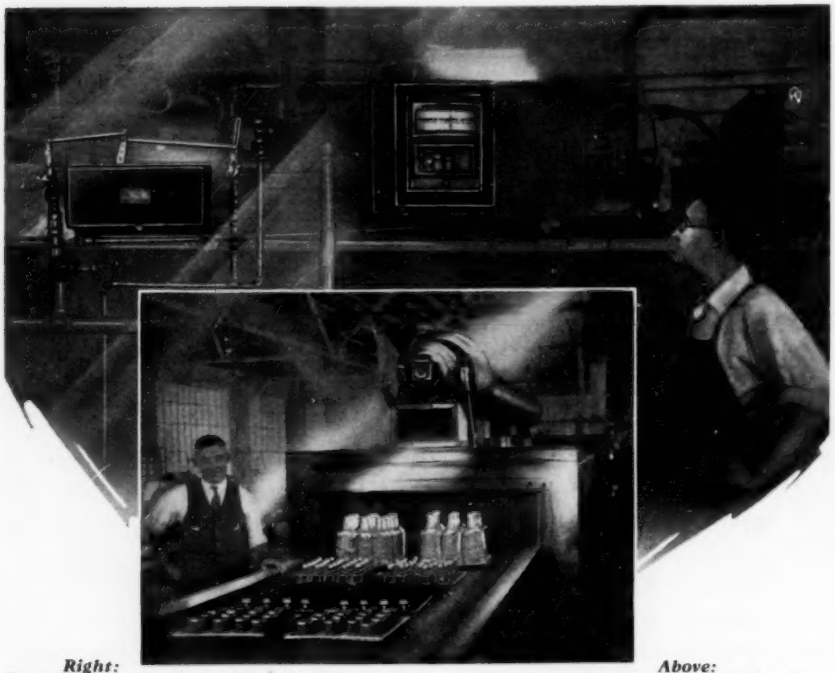

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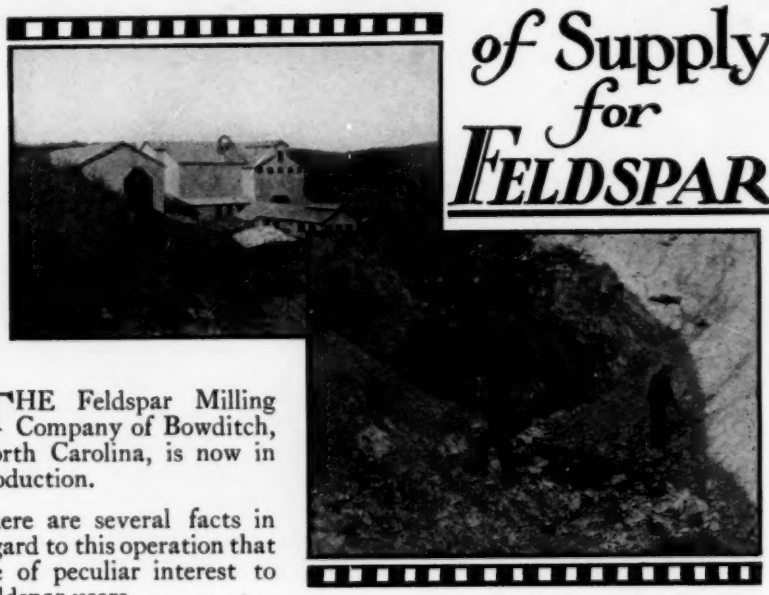

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REFRACTORIES AND REFRACTORY CEMENTS FOR THE NON-FERROUS FOUNDRY[1]

By Harold E. White

ABSTRACT

Development in refractory linings for the various furnaces encountered in the non-ferrous foundry industry is outlined, and figures given showing the present trend. These include open-flame, crucible, and electric furnaces. The open-flame furnaces formerly used firebrick linings, but silicon-carbide and high alumina refractories are coming into use. The crucible furnace linings show a decided preference for silicon-carbide refractories, while the electric furnaces are partial to the alumina and mullite bearing types.

Progress in the manufacture of refractory cements and their use in the various types of furnaces is discussed. Data are given which indicate that the use of the proper types of cements for maintaining furnace linings of similar composition is becoming more general.

Introduction

Ancient History The study of refractories and refractory cements is almost as ancient as the origin of fire. When man first learned to surround his fire with stones he studied the effect of the fire on the various kinds of stone and frequently observed the phenomena of spalling. He undoubtedly used clay to chink up the spaces between the stones and to repair any broken-down sections of his fireplace, thus utilizing a crude maintenance cement for the first time.

Wiping his clay-covered hands on his own hairy chest gave him the idea of using hair in plaster and fibrous refractory substances such as asbestos in his maintenance cements.

He observed that the fired clay particles were very resistant to heat and were hard to distort or disintegrate and, as clay was abundant, it was freely used. A study of the ancient iron furnaces shows that they were lined with fire clay and reinforced by a backing of stone blocks.

It would be difficult to determine exactly when and where the first fire brick were made, but it is known that the medieval alchemist was adept in making crucibles, retorts, and small furnaces. In the fifteenth century considerable progress was made in the metallurgical and ceramic industries and this was made possible by the use of crucibles and furnaces made from heat-resisting materials.

Definition Ceramically speaking, refractory materials are such that they may be subjected to a temperature of at least 2700°F without suffering deformation. From a metallurgical point of view this definition is as narrow as that describing a violin as being wood and catgut.

While refractoriness is a fundamental characteristic of all the materials employed in furnace construction, the various chemical and physical in-

[1] Presented at the Annual Meeting, American Ceramic Society, Toronto, Ont., February, 1930 (Refractories Division).

fluences acting upon the refractories, such as the deteriorating effects of vapors, gases, fused slags, and molten metal, fluctuations of temperature, pressure, etc., are really of much greater immediate interest, particularly since it is easy enough to find refractories of sufficiently high softening and melting temperatures to stand the comparatively moderate heats involved in general nonferrous metallurgy.

Kind of Refractories

The refractory most generally used is fire clay. It does not represent one definite substance or compound, but a mixture of various acid and basic components. Its properties may be greatly influenced by suiting the composition of the refractory mixture to the large variety of conditions involved.

It is to the super-refractories, such as silicon carbide, aluminum oxide, and mullite that the operator of nonferrous metal melting furnaces must look for increased lining life and resultant decreased lining cost, for in spite of high initial refractory cost, it amounts to a few dollars when an old lining must be torn out and a new one installed, especially when the furnace is badly needed.

It is almost needless to say that low thermal conductivity materials such as diatomaceous earth are required to insulate linings of high thermal conductivity properly. This is especially true with silicon-carbide linings. Instances are still being cited, however, of silicon-carbide grain being used to back up a lining of the same material resulting in tremendous heat loss.

Refractory Cements

During the last ten years the development in refractories and refractory cements has been necessarily as intensive as the development in the fields which these products serve. This is particularly true of the nonferrous and special alloy melting field.

It is the purpose here to review the development of recent years in this particular field. This paper is divided into four principal divisions: (1) open-flame furnace linings, (2) crucible furnace linings, (3) electric furnace linings, and (4) refractory cements. Particular attention is called to the fourth division as some interesting comparisons have been uncovered.

Refractory Linings for Open-Flame Furnaces

So-called open-flame melting is one of the oldest types known. The first metal melted was probably done in this manner. The advent of gas and oil fuel, however, changed the problem completely, especially for the nonferrous foundry which required a large production of heavy rough castings such as is found in the average railroad shop.

The open-flame tilting, open-flame rotating, and reverberatory types of furnaces were investigated in their relation to the foundry industry only. As the last named type is used very little in foundries, but principally in smelters, it is not covered in this paper.

The remaining two types use either oil or gas and at the present writing a

daily capacity of 300 tons is reported from approximately 40% of the total metal melted in this country.

The types of furnaces considered are (1) vertical barrel type, non-rotating; (2) horizontal barrel type, flame directed from one end only rocking through a portion of a circle; (3) horizontal barrel type rolling in one direction through a complete arc, flame from both ends; and (4) egg-shape tilting.

These types of furnaces are used usually for (1) heavy work where emphasis is given on production and low cost; (2) where a large proportion of scrap is melted; and (3) where due to the nature of the metal melted or some other factor involved it is necessary to use heavy fluxes.

Data Obtained by Survey By far the largest proportion of the furnaces investigated are lined with ordinary fire brick. This represents 62% and the average heat life of these linings is 785. Six per cent of the furnaces are lined with plastic brick at an average heat-life of 300 heats. Fifteen per cent are lined with silicon carbide material at an average heat-life of 980 heats.

The following comparison between 1926 and 1929 covers types of linings.

	1926	1929
No. of foundries investigated	41	36
Fireclay type (%)	68	44
Silicon-carbide type (%)	15	34
Alumina-silica, mullite, or aluminum oxide types (%)	3	11
Unknown (%)	14	11

Note the remarkable increase in both the silicon-carbide type and the alumina-silica type. The decrease in the unknown types which represent the disinterested consumer is also pleasing.

Cause of Failures Refractory linings in these furnaces fail from a number of causes, some of which are peculiar to this type of furnace. These are (1) spalling (low resistance to thermal shock), (2) cutting action of the flame, (3) fluxing action of floating slags, (4) fluxing action of particles of slag thrown against the refractory by the blast, (5) mechanical injury due to charging heavy pieces of metal, (6) chipping out adhering slag, (7) low P.C.E. for temperatures involved, (8) disintegration by metal penetration, (9) penetration by liquid or gaseous fuels, and (10) chemical attack by various metals and fluxes.

Other Factors Considered In addition, the following factors should be considered by the purchaser, (1) heat conductivity, (2) ease and convenience of installation, (3) physical behavior on pouring, (4) ease of maintenance, (5) mechanical strength, (6) least possible change in volume under all working conditions, (7) durability or the ability to retain its good qualities after a long period of use and abuse, and (8) uniformity, chemically, physically, and mechanically.

Plastic Mixtures When fire brick was the only lining on the market the only choice possible was in selecting the various grades. The first development was in plastic mixtures, and in using super-refractory cements to lay up the firebrick lining.

Varying experiences with plastic mixtures containing silicon carbide offer a striking example of inconsistency in results obtained by different users. In many respects it is an ideal brass furnace refractory, since it is almost entirely free from cracking and readily forms a vitrified surface which is very resistant to heat or ordinary wear. With high zinc alloys containing little or no lead its resistance to metal penetration recommends it highly and its use meets with almost unvarying success. With percentages of lead in excess of 3% various users report most radically different results. Some have no difficulty at all, others get good results part of the time.

A well-glazed lining in which the silicon-carbide crystals are protected by the glaze from attack by the lead will run for long periods of time without the slightest sign of trouble. It is naturally easier to glaze the lining of an open-flame furnace than most any other type and silicon-carbide mixtures tend to glaze easily.

Mullite, using this name to include also converted sillimanite, andalusite, etc., offers distinct promise, but in plastic mixtures it is difficult to bond without impairing its good qualities. Properly bonded, it is free from spalling, cracking, and metal penetration.

Chrome-ore refractories have not seemed as promising as mullite or silicon carbide for this use.

Prefired Super-Refractories New super-refractory prefired linings are on the market in various shapes. These show promise particularly where they are so made as to present a minimum of joints parallel to the cutting action of the flame. By this simple device it has been possible to prolong lining life by cutting down the gas erosion at the joints which is quite pronounced in open-flame furnaces.

If the foundries will coöperate by keeping a careful record of their experiences and compare notes freely both with their competitors and with the refractory manufacturers, there is some prospect of substantial improvement in the near future for this type of lining. The manufacturers of refractory specialties and the firebrick manufacturers seem inclined to be liberal in carrying out their share of the development work.

Refractories for Crucible Furnaces

Crucible furnace linings were originally of ordinary fire brick for the coke or coal pit type where the refractory problem was not serious. When oil and gas came into use the manufacturer frequently used his old coke or coal pits with the result that the installation was either very inefficient or the lining failed quickly.

With natural draft there was little erosive action, and the ordinary fireclay refractory served admirably. The introduction of the gas and oil furnaces, stationary and tilting types, brought new problems which have increased steadily with the demand for faster melting and higher temperatures required by a multitude of new metal mixtures.

There are three separate refractory problems, exclusive of the crucible, in a crucible furnace: the furnace cover, base block, and lining. Two of these are peculiar to the gas and oil furnace, namely, the furnace cover and the base or rest block.

The Cover The furnace cover offers a number of problems. It is subjected to repeated heating and cooling, with the resultant expansion and contraction. It must resist the highest temperatures existing in the furnace on one side with room temperature on the other. Through its exhaust hole the high temperature gases at high velocity have a terrific fusing and erosive action.

The silicon-carbide cover has been the most serviceable one yet developed. It has high physical strength and when supported properly will not crack, readily spall, or sand away. Its extremely high-temperature resistance is particularly effective at the exhaust hole. This cover can be made in one piece or in segments and with replaceable center inserts, which guarantee the exact maintenance of the exhaust hole throughout its life. Three to four times the life of a fireclay cover is often reported and in some cases service of over a year is obtained.

The Rest Block A crucible should be centered exactly in the furnace; otherwise combustion efficiency is impaired and the life of the crucible is reduced by the effect of different temperatures on opposite sides of the crucible. The crucible should also be maintained at a given position in the furnace in relation to burner position and clearance under the cover, for proper performance. A base or rest block that will not soften, spall, or squat is necessary for this.

The block should also be a good conductor of heat to insure using all of the surfaces of the crucible for heat transfer, resulting in greater combustion efficiency and increased crucible life.

Super-refractory rest blocks made either from silicon carbide base mixtures or from graphite crucible mixtures have overcome most of the difficulties encountered in present-day melting.

The Lining The furnace lining itself is the most important of the three items.

The first attempt in improving lining service was the use of plastic material to apply against the brick. Following this, superplastics were used such as silicon carbide base materials and other high melting point refractories. These were a further improvement but offered the disadvantage of

the time-interval and experience required for relining. Unless properly installed less than normal life often resulted.

Both the fireclay and the silicon carbide plastic lining require constant maintenance and the expense incidental thereto. Later, prefired block type linings came on the market.

Design of New Silicon-Carbide Lining The latest addition is super-refractory concentric rings that fit into the furnace and are backed up with heat insulating material.

The lining is made up of four or five annular rings. The burner and slag holes, and any other openings required, are built into the lining in exact position and of proper size and contour.

To install the lining it is only necessary to drop the individual rings, which are easy to handle, into their position in the furnace in the order laid out and marked. A thin layer of joint cement is spread on each ring. The lining can be put into operation immediately. The average time for the complete installation, from the start, until the heat is turned on, is about one hour.

The use of silicon carbide has provided a fly-wheel action to this type of melting furnace. The specific heat of bonded silicon carbide has been determined as 0.180, while fire brick is 0.192. The increase in weight per unit volume or bulk density over fire clay, however, is about 30%. The thermal capacity of a given volume of silicon carbide is therefore higher than that of the same volume of fire clay. The relative emissivity factors also should be considered. Silicon carbide has a 50% higher radiation factor than fire clay. These factors allow for the storing of a sensible amount of heat during the period when the crucible is removed from the furnace and provides rapid acceleration on the next heat.

Insulation Greater fuel efficiency is often obtained through the insulation of the furnace walls. Such practice, however, should be followed only with considerable care. The use of an extra thickness of insulating material to reduce the heat loss from the cooler sides of the wall will result in a higher furnace temperature and a deeper penetration of heat into the brick. This means that the refractories are under more severe conditions of service and usually cause a hastening of eventual failure. Then, too, the temperature gradient of the refractory furnace lining must be such that the insulation will not be subjected to temperatures above its destruction point.

Shell In other words, the furnace shell should be of such a design to allow ample cooling and proper radiation as all of the heat cannot be dammed up. This means that furnace design is a very important factor in the life of refractories. It would be cheaper in the long run to consult a recognized furnace manufacturer than to make a furnace by cutting the top from an oil drum and sticking a burner made from pipe fittings into the side.

Operation The personal element with respect to the installation and maintenance of linings and the operation of furnaces is of prime importance. Variations in this respect are frequently so great as to obscure the effect of all other factors governing lining life.

When a crucible furnace is newly equipped with refractories, it is ready to operate at its greatest efficiency. The diameter and walls of the lining are correct. The exhaust hole in the cover is exact to design and the crucible is properly positioned and supported by the base block.

The combustion areas of a lining are enlarged under conditions of use, thus increasing the amount of fuel necessary to maintain a given temperature. The exhaust hole in the cover is also enlarged. This allows more rapid escape of the exhaust gases, and tends to lower the temperature of the furnace. The burning of pockets in the lining throws the combustion out of balance and creates zones of widely varying temperatures around the furnace, shortening the life of the crucible. Experience of many years has shown that crucibles give their best service in well-conditioned linings.

Preglazing of silicon-carbide linings to increase their life and prevent growth due to oxidation and gas attack is now being done very efficiently by most manufacturers, and this is no longer demanded of the customer.

Types of Furnaces Types of furnaces are also changing. When the first crucible furnaces using gas and oil were built they were nothing more than a combustion chamber in which a crucible was placed. There was no attempt made at preheating or recuperation and the efficiences were very low. At the present time there are furnaces on the market which are intelligently designed. Combustion takes place in a separate chamber or chambers using preheated air from recuperators. The metal is preheated in a refractory container which is above the crucible and allows the entire charge to be inserted at once. They are twice as efficient as the older types.

Attention is being given to the proper swirling motion of the flame. Furnaces with grooves cut in the lining to direct this swirling motion are on the market as well as furnaces which have decreased combustion space at the top of the furnace and tong grooves to facilitate removing the crucible.

In the year 1926 the Joint Committee on Foundry Refractories, nonferrous survey, accumulated data covering refractories for the nonferrous industry. These data have been brought up to date and a comparison is given covering types of linings in use at the two different periods. There are so many foundries using crucibles from which data are not available that only the forty-one foundries replying to the original questionnaire were considered.

	1926	1929
Fireclay type (%)	63.5	41.5
Silicon-carbide type (%)	31.5	51.5
Alumina-silica, mullite, or aluminum oxide type (%)	5.0	3.0

There has been little change in the coke and coal pit type of linings and what little has been done is in the direction of high alumina fire brick or other high alumina mixtures and some silicon carbide.

There has been a tremendous advance in the use of silicon-carbide refractories. A large proportion of this is due to the presence of silicon-carbide firesand plastics on the market which are both relatively cheap and durable although difficult to install.

Refractory Linings for Electric Furnaces

Furnaces can be designed to make use of the ordinary refractories and obtain good service, but this is done at the expense of good operation and efficiency. The use of costly refractories is often economically sound. Lining such furnaces and preparing new linings for service are comparatively expensive operations, involving a loss of production which is particularly serious because of the large investment in the furnace equipment. On the other hand, electric furnace operation lends itself to long lining life under favorable conditions, so that a lining of high cost per pound may easily be cheaper to use than a cheaper but less durable material. Materials for this service which are either in common use or the subject of active experiment include kaolin-asbestos mixtures, diaspore clays, silicon carbide, minerals of the mullite group, and chrome ore. The first named is not sufficiently refractory for most electric furnace service, but has been successfully used in the induction furnace for melting yellow brass.

In 1920 there were twelve types of electric furnaces available for melting of nonferrous metals, four of which were induction furnaces, one of these a resistance type, and seven arc type furnaces. In 1929 there were practically only three available, the Ajax-Wyatt induction furnace, the Ajax-Northrup high-frequency induction furnace, and the Detroit indirect arc rocking furnace.

Indirect Arc Electric Furnaces

In many cases a high alumina fire brick such as diaspore and kaolin is used. This type of lining is especially good on yellow brass but not as efficient on red brass and alloys having higher pouring temperatures. Periodical patching is almost universal, although details of practice vary widely. Daily hot patching and weekly cold patching give best results. Preheating is universal although there is considerable variation in the nature and duration of the preheat. Spalling is the most serious single factor in shortening lining life, although penetration of the brick by metallic vapor or oil from the charge is also destructive in certain plants.

One distinct characteristic of nearly all types of refractories used in this type of furnace is the tendency to spall just above the door. Apparently this section which is not glazed by the metal wash and which is overheated by the action of the electric arc is also the most rapidly cooled when the

furnace is opened for charging. This furnace requires a different refractory structure for the electrode sleeves, door, and barrel piece. It is desirable due to the tendency to spall to provide a more open structure on the roof of the furnace.

Low-Frequency Horizontal Ring Type

The manufacture of this furnace has been discontinued. It was difficult to operate due to electrical pinch effect. The chief reason, however, for the failure of this type has been due to the refractories and the difficulty of maintaining a metal-tight channel or hearth. In the few furnaces now operating, high purity sintered magnesium oxide bonded with magnesium oxychloride and rammed in place seems to be the most satisfactory lining. Mixtures of crystalline alumina and magnesia have also been tried.

The Ajax-Wyatt Induction Furnace

In this furnace the path of molten metal forms a complete loop around the inductor coils. Therefore, to prevent serious coil trouble the refractory wedge containing this metal must be of high quality. Formerly, plastic refractories were used to form the entire furnace lining. More recent practice is to use a prefired wedge-shaped piece containing the metal channel in the lower portion of the furnace, lining the upper crucible with plastic refractory material.

The greatest problem connected with the development of the submerged channel type induction furnace has been that of refractories.

The refractory wears through due to erosion by moving metal and due to the penetration of molten metal into cracks and pores of the refractory.

Furnaces of this type are not used extensively for melting foundry red brass. Reports at the time of the 1926 survey showed less than 5% of the total melt handled by this furnace, and nearly all of this was foundry yellow brass; this figure, however, has been steadily increased. The average lining life varies from 700 to 1500 heats and averages 990. When plastic mixtures of comparatively low refractoriness are used at yellow brass temperatures, such linings are quite reliable and long lived.

The refractory lining in the V-shaped heating channel of the induction furnace is very thin. Rapid melting requires that the metal temperature at or near the point of the V should exceed the normal pouring temperature of the alloy by perhaps 400°C or 500°F. At this point the lining must be sufficiently refractory, very dense in order to resist penetration by the molten metal, and must under no circumstances develop even superficial cracks as a result of temperature changes. Since the electric current passes through the metal in direct contact with the lining it goes without saying that silicon carbide or other materials of high electrical conductivity cannot be used. Any considerable proportion of lead in the alloy has a tendency

to cause excessive penetration of metal into the lining and such alloys destroy the lining rapidly.

The applicability of the induction furnace to foundry work would be greatly increased if it could be furnished with a lining which would consistently resist penetration at temperatures above 2500°F when used for melting red brass alloys containing moderate percentages, about 5 to 10%, of lead. Clay base refractories have not been successful here.

The furnace is lined by first placing asbestos paper next to the shell, then a layer of Sil-O-Cel brick or similar insulating material against which the refractory cement is tamped and rammed around prepared forms in successive stages until the V-shaped bottom and cylindrical shells are completely filled with rammed-in refractory. The forms are clamped in place to secure the proper size and shape of channel, forming the secondary part of the circuit, the opening for the transformer coil, and the chamber. Of late years the channel and opening for the transformer coil have been furnished in a prefired block.

Great care must be exercised in placing the insulation, as its inherent shrinkage will often allow the plastic refractory to sag and crack.

Chrome-ore plastic linings have been used in these furnaces when melting alloys of less than 90% copper. The channel block is the weak part. The status of this combination of lining and metal was not exactly determined, although it is known that many furnaces melting yellow brass use chrome-ore plastic linings for the chamber and clay refractory for the channel block. Sintered magnesia compounds have been used similarly.

High-Frequency Coreless Induction Type Furnace

The high-frequency induction furnace of the Northrup type seems to be the most promising invention of the age which affects this industry directly. Its most outstanding feature is the fact that it utilizes an old and well-recognized principle of melting; that is, the use of a container or crucible for holding the molten metal which keeps the metal absolutely free from any possible contamination from fuel or any harm due to localized overheating. Containers are readily obtained and of long life, and the long experience of the crucible manufacturers is embodied in them. The linings are of uniform thickness and there is no one weak spot as in some of the other types of induction furnaces.

The equipment to produce the current is elaborate, but the furnace itself is simple. Any trouble experienced with the lining does very little damage to the equipment.

There is no necessity of elaborate insulation with its possibility of shrinkage.

For ordinary melting of nonferrous metals typical graphite structure crucibles may be used; these may also be used for high carbon steel. For

special steels, however, it is necessary to go to magnesia, aluminum oxide, or similar containers.

In the Ajax-Wyatt type, if the refractory lining is allowed to cool it is apt to crack on re-starting. In the coreless induction furnace the necessity for a resistor channel is avoided. An ordinary crucible or else a more shallow hearth of the same material may be used. In either case the furnace may be emptied of its entire charge and re-started with cold metal.

All the advantages of crucible melting are obtained with none of its disadvantages. The crucible may be protected by a granular refractory backing inside a mica sheath, then when the crucible is worn out and cracks, the charge may be poured out without loss or damage.

Crucible life is long and may in some instances be maintained indefinitely by the proper use of certain cements such as alumina, magnesia, and zirconia base cements.

It has been difficult to obtain reliable data on the induction furnaces, especially of the Northrup type due to the large amount of experimental work in which these furnaces are being used.

Refractory Cements for Nonferrous Melting Furnaces

The efficient utilization of heat in many industrial processes depends upon refractory materials that may be placed in position upon short notice and which will either take the place of, reënforce, or bond together parts of the parent refractory structure. Refractory cements have been developed to meet these requirements.

Their use has greatly increased within recent years. So many inferior cements were on the market a few years ago that all of them were viewed with suspicion by many consumers. Competition and experience has caused the consumption of the poorest ones to decrease materially and today most of the cements on the market possess a degree of merit for the purposes for which they are adapted. Most of them if properly used will give highly advantageous results.

A large number of mixtures and brands of plastic cements have been used. The most popular still seem to be materials of high plasticity and questionable worth, although cheap in price. It is apparent that the ease of application and the price are the biggest factors which formerly and still in a large degree interest the consumer.

Materials such as silicon carbide, fused alumina, and the mullite-bearing minerals have been utilized and find application in many types of service. Their necessarily high cost when calculated into production per unit of refractory and when properly applied easily compensates their use. Such materials usually lend themselves to the development of specific properties to a high degree.

There is a tendency for fireclay cement manufacturers to use better clays

and calcine and it is difficult to draw the line between the kaolin mixtures and the ordinary flint clay mixtures, especially when some cements contain a mixture of both.

After the development of the usual clay plus calcine type of refractory cement, the mixtures using silicon carbide were evolved. These, due to their durability, although fairly high in price have been very popular. If properly used for the proper types of metal they are satisfactory.

Later, cements of high-grade fire clay and diaspore were brought out. These have not been particularly successful either from a price or service standpoint, but if efficiently used will earn their cost.

The most recent developments are the mullite-bearing, alumina-silica, fused alumina, and special cements such as chrome cement and zircon cement. These are still higher priced, but can easily earn their cost by their durability.

Further development of the remaining base materials that offer possibilities for refractory products is improbable.

Properties Essential in Cements

Withstanding high temperatures is only one of a large number of essential properties for long life of refractory cements. In fact, the name "refractory" has been chosen in place of the frequent "high temperature" or "maintenance" as these cements must stand more than high temperatures and frequently this is the least consideration. The term "maintenance cements" might be more applicable in this specific case but a good refractory cement should also qualify on new constructions as well as maintaining old ones.

The conditions under which refractory cements are used require a combination of properties, any of which singly could be developed to a high degree with the present raw materials. It is necessary, therefore, to compromise and balance the general properties with the specific. Considering a common condition in service where slagging and spalling are severe, the use of a clay-bonded refractory cement for the slagging would warrant a dense structure to prevent penetration of the slag, while for spalling a more open or porous structure would normally be used. With this combination of conditions it is desirable to employ a cement which will fire to intermediate density, sacrificing the resistance that could be supplied if either condition were present alone.

Conditions such as these complicate the development of special refractory cements. It is exceedingly difficult to obtain dependable service records to guide the manufacturer or the consumer in learning the actual value of the material in his service.

Given a new and unfamiliar product, two independent furnace men will frequently return violently contradictory reports of its value and behavior under supposedly similar conditions of service. The injustice of this is at

once apparent since it reflects upon the purchaser in the one case and the manufacturer in the other.

Due to these inconsistencies the most carefully controlled product can meet with but indifferent success unless in its installation and use it receives the whole-hearted interest and intelligent application of the man in whose hands it is placed.

The high first cost of super-refractory cements is no longer the stumbling-block it was four or five years ago. There are examples by the score and the logic of the matter is becoming so clear to the thinking executive that it is not a question of whether or not he can afford to buy them, but what can he save through their use.

The accepted practice of grading a refractory cement seems to be by its melting point. A cement having a definite P.C.E. value and which maintains constant volume up to it, will prove more serviceable than one which has an apparent melting point of 100° or more higher than the stable product, with an inconstant chemical composition.

Unfortunately with the known commercial methods of manufacturing refractories it is not possible to turn out at merchantable cost a satisfactory article made from some of our best materials from the standpoint of melting point. Definite tests of refractory cements other than their P.C.E. value should be studied. Naturally these cannot cover all conditions but if the same weight is given to only a few of the other desirable properties in the next few years that have been given to P.C.E. values in past years, advancement in the art will be very rapid.

This is easier said than done, but some advance can surely be made; in fact the time has come when the customer demands it and this means that it has to be done.

Present Trend in Use of Refractory Cements

In compiling the following chart showing the relative use of the various types of cements, the 1926 data covering eighty-one foundries were secured from the Joint Committee on Foundry Refractories, nonferrous survey, and the 1929 data taken from industrial service reports covering one hundred and ninety foundries.

	Crucible furnaces		Open flame		Electric	
Number of installations	45	138	39	35	29	40
	1926	1929	1926	1929	1926	1929
Fireclay, ganister and allied cements not truly super-refractory (%)	44.5	17.5	36	17.25	27.5	2.5
Silicon carbide super-refractory cements (%)	53.25	74.50	61.5	74.25	52	37.5
Aluminum oxide, alumina-silica, mullite, and allied super-refractory cements (%)	2.25	3.50	2.5	2.75	20.5	57.5
Chrome ore base (%)		2.25		5.75		2.5
Unknown (%)		2.25				

It is curious that a few companies still continue without the use of maintenance cements.

The preceding table shows conclusively that the use of super-refractory cements is on the increase. Curiously enough the figures for open-flame melting follow those for crucible melting. These figures are merely on installations and are not weighted averages.

There is a marked tendency for improvement in the super-refractory cements the last two years and this is especially true of the silicon carbide and alumina-silica types.

Attention is called to the entirely different arrangement of percentages covering the electric furnace installations.

The alumina-silica cements are particularly suited to this class of work although some operators prefer silicon carbide which, due to its electrical and chemical properties, must be intelligently used if success is to be attained.

It is not exactly fair to compare lining life on the basis of maintenance cements used. The properties of the original lining affect this to a great degree as also do the furnace practice, metals melted, and method of patching. There are, however, widely variant instances using as near as can be ascertained the same lining materials and having the factors comparable. Two of these cases are on record, both using similar types of furnaces and similar brick linings, one averaging 75 heats per lining using fireclay and sand for patching the lining, and the other obtaining 1500 to 2000 heats using a super-refractory maintenance cement.

Properties Required From the "Utility of Refractories" chart* we take the headings, "strength," "resistance to destruction," "confinement of heat." A good refractory cement must be all this and more. It should have the following properties: (1) elasticity or ability to adapt itself and cling to unlike materials having different coefficients of expansion, (2) mechanical strength to maintain loads at high temperatures and not crumble or bloat, (3) high P.C.E., (4) resistance to abrasion, (5) low shrinkage, (6) resistance to disintegration (low porosity to prevent dissociation by gases), (7) chemical resistance (slagging), (8) resistance to spalling, (9) long vitrification range, and (10) workability.

Confinement of heat is a minor item with most refractory cements when used for maintenance only but must be considered when used on new work as a bonding mortar or when used for the entire structure as a semi-plastic ram.

It is evident from the above properties that thorough analysis of each is a very complicated matter.

In every function there are a number of independent factors which interact in a manner defying accurate analysis. Each function is dependent

* Issued by the American Refractories Institute.

upon every other one. For example, it is difficult, if not impossible, to determine the resistance to abrasion of a cement in service because of the many factors involved and because the hardness itself changes in undetermined degree with changes in temperatures.

In many cases the temperature of the furnace is sufficient to cause the hot end of the cement to vitrify, that is, to develop a glassy texture for a short distance back of the hot face. Almost invariably a line of weakness develops between the vitrified portion and the portion of unaltered texture or between the cement and the parent furnace wall. Temperature changes will generally cause spalling along a line of weakness of this kind. Slags absorbed by the end of the structure may cause similar vitrification and spalling. Cases are not infrequent in which the cement will withstand rapid temperature changes without deterioration until the hot end has become vitrified or filled with slag.

The working quality of the cement is of considerable importance. A smooth working, easily used mortar is highly desirable and from a standpoint of labor ranks first in importance. Actually the only influence it should have is in the consideration of costs. Labor costs are lower if the cement is smooth working, but other desirable properties should not be sacrificed to produce a mortar which will spread like fat clay. In general, the shrinkage of the mortar increases with improvement in smoothness.

The relative elasticity or ability of a cement to allow unequal expansion either between its own structure and the parent refractory or between two parts of the structure which it is bonding together is a valuable characteristic which unfortunately is missing in many refractory cements. It seems unreasonable to expect a ceramic body to be elastic but while the elastic limit is low, there is yet a small degree of elasticity. Refractory cements should have this property developed to its fullest possible extent.

The subject of air-setting cements must not be passed over. This feature is accomplished either by the addition of sodium silicate or by organic-bonding materials such as gums and pitches. Sodium silicate naturally affects the refractoriness of the cements, but on the other hand some organic bonds cause disruption of the permanent bond under certain firing conditions. This is especially true of clay-bonded cements using clay-mineral grog. It is not so pronounced in silicon-carbide cements using clay as the permanent bond and is seldom noticed where chrome ore or silicon carbide is used with synthetic mineral bonding agents.

Present Status of the Industry

In studying the cements now available and as supplied to the ultimate consumer so many are marked "special" that considerable confusion results.

The advertised properties are also confusing. Such statements as:

(1) "It has approximately the same coefficient of expansion as the materials joined." (Without any statement or restrictions to the material

to be joined.) (2) "It contains just enough water to hold it together." (3) "It is a neutral refractory." (Neutral to what? The writer has seen a chrome brick disappear overnight in a metallurgical furnace from a peculiar slag attack, and yet chrome is more nearly neutral to most acid and basic slags than any refractory now in use.

One manufacturer condemns sodium silicate and another recommends it. One condemns the addition of water and others (by far the majority) recommend it.

Many put considerable weight on P.C.E. tests, when these constitute only one of the many required properties of refractory cements.

It is lamentable that some of the advertising propaganda put out by some of our largest manufacturers is absolutely unsupported by scientific data or fact. A few of them are, however, honest and curiously enough they are the leaders in quality.

It is frequently stated that the various ingredients of a cement melt at certain high temperatures, whereas all mixtures melt at lower temperatures than the pure article.

It is commendable that so many of the more prominent manufacturers stress the preparation of cements. It seems an easy matter to add water to a dry cement but the best properties are only brought out when the mixing is properly done in machines especially designed for the work and the cement allowed to age to complete the solution of bonding ingredients.

In this connection, it is frequent practice for the man who uses the cement to add clays, ganister, crushed brick, or crucibles and even certain fluxing agents, such as common salt, Portland cement, lime, or ground slag. It cannot be denied that fair results have sometimes been obtained by cement prepared in this manner. While the good results are reported and sometimes broadcast, the failures seldom come to light, but may nevertheless be expensive. In most cases savings will be effected by purchasing refractory cements from an established and reliable manufacturer and using them as prepared rather than depending on these homely concoctions.

One manufacturer recommends sifting dry cements into hot water, agitating constantly, and allowing to stand overnight. This is excellent practice.

Careful attention is given by the manufacturer to the screen test of the various materials which constitute these cements. The blending of the different components has also been studied. The consumer should therefore be careful not to upset these conditions.

A table showing the approximate composition of forty-nine different cements follows: This is based on numerous chemical analyses and elutriations over a period of several years. Authenticity of several samples has, however, been hard to establish as they have of necessity been secured on the open market and through others interested in this work.

Excellent cements have been developed for almost every conceivable condition. To enumerate the conditions and specify the cement is a large problem which space will not permit us to deal with here. It is hoped, however, that by showing the general trend for the various uses an unbiased opinion will be rendered to assist those who desire it in the selection of the proper type of cement.

REFRACTORY CEMENTS
APPROXIMATE PHYSICAL ANALYSES

Code no.	Fireclay and allied mixtures	Approx. P.C.E. (Temp. °F)
1	25 % raw clay, 50% grog, 15% ganister, 10% water	2600
2	30 % raw clay, 60% grog, 10% water	2600
3	20 % raw clay, 65% calcine, 15% water	2600
4	20 % raw clay, 65% calcine, 15% water	2600
5, 6, 7	Acid siliceous mixtures	2800
8	80% silica, 15% clay, 5% organic bond, 10% water	2800
9, 10, 11, 12	44% raw clay, 6% sodium silicate, 50% water	2200
13	25% raw clay, 10% asbestos fiber, 65% calcine	2600
14	25% raw clay, 65% calcine, 10% water	2800
15, 16, 17, 18, 19, 20, 21	65% calcine, 20% raw clay, 15% water	2700
	Silicon carbide base	
22	70% silicon carbide grain, 15% clay, 15% water	3300
23	85% silicon carbide grain, 15% clay	3400
24	35% silicon carbide firesand, 35% calcine, 20% raw clay, 10% water	2700
25, 26	80% silicon carbide firesand, 15% raw clay, 5% organic bond	3300
27	85–90% silicon carbide grain, 5% organic bond, 5% chrome ore	3400
28	85–90% silicon carbide grain, 5% organic bond, 5% zircon, remainder synthetic bond	3400
29	75% silicon carbide grain, 25% raw clay	3200
30	Silicon carbide firesand, silica, clay	2700
31	50% silicon carbide firesand, 25% asbestos fiber, 25% clay	2700
	Aluminum oxide—alumina-silica, mullite, etc.	
32	75% calcined diaspore, 25% raw diaspore clay	3150
33	75–85% crystalline alumina, 15–25% prepared clay	3500
34	85% calcined kaolin, 15% prepared clay	3300
35	60% calcined cyanite, 30% blended clays, 10% water	3200
36	70% electric furnace mullite, 20% blended clays, 10% water	3250
37	85% kaolin calcine, 15% raw kaolin and synthetic bond	3250
38, 39	75–85% crystalline alumina, 15–25% plastic clay	3500
40, 41	75–85% crystalline mullite, 15–25% plastic clay	3250

	Unknown	
42 43 44	Samples examined but quantity too small to work on	
	Chrome ore	
45	60% chrome ore, 3% sodium silicate, 25% clay, 13% water	2800
46	90% chrome ore, 5% clay blend, 5% synthetic bond	3500
47	Chrome ore, clay, sodium silicate	3100
48	Chrome ore, synthetic bond	3500
49	Chrome ore, clay, synthetic bond	3500

Conclusion

The universal use of firebrick and fireclay refractories for nonferrous foundry furnace linings is rapidly becoming obsolete. No one new material is taking its place but a series of new refractory products along with which has been developed super-refractory cements of similar compositions.

Crucible furnace preferences lean toward silicon-carbide refractories maintained with silicon-carbide cements. Open-flame furnaces follow their lead but a growing minority of this class is using the alumina and alumina-silica combinations. Electric furnace users generally favor the high alumina and mullite-bearing structures with some chrome ore and sintered magnesia linings being used in induction furnaces.

The use of super-refractory cements seems to have expanded beyond the field of super-refractory fired shapes as the life of fireclay refractories is being increased by installing new work and maintaining old ones with these materials.

LAVA CRUCIBLE COMPANY OF PITTSBURGH
ZELIENOPLE, PA.

Discussions

F. A. HARVEY:[1] When an attempt is made to obtain data on the performance of any type of furnace the difficulties encountered are manifold. First, to learn where the furnaces are in operation and second, to obtain information on their performance. Mr. White is to be complimented on obtaining data on such a large number of nonferrous melting furnaces and we appreciate the time and large amount of correspondence necessary to accumulate these data.

Considering the paper as a whole, the author emphasizes the use of silicon carbide and mullite. Silicon carbide is the older of the two refractories and it has shown peculiar adaptability to this particular type of furnace. A certain percentage of mullite exists in practically every fireclay or high-

[1] Harbison-Walker Refractories Co., Pittsburgh, Pa.

alumina refractory but its use under its own name is comparatively new and, according to Mr. White's table, the refractories which can be classed as primarily composed of mullite are as yet sparingly used in this industry. As the title states, the paper is confined to nonferrous foundry, but the data on percentages of various types of refractories do not attempt to represent the nonferrous industry as a whole. There is a much larger consumption of refractories in the reduction of the ores than there is in remelting them in the foundry. Also aluminum remelting furnaces are not specifically mentioned in this paper. In the first table given by Mr. White, chrome refractories are not mentioned although they have found a considerable application in this industry. Possibly chrome is included in the 11%, listed as "unknown."

We do not believe the manufacturer of refractories has any disinclination to keep service data. Our general experience is that he wants and needs much more information than he is able to get. As a rule, the manufacturer must depend on his salesmen for information on the use of products and the salesmen's time is naturally primarily devoted to sales, the accumulation of data being a side issue.

In discussing the types of refractory used for electric furnace linings, diaspore clays are mentioned but other high-alumina refractories should also be included.

Mr. White indicates that induction furnaces are limited to the production of yellow brass. This view is doubtless due to incomplete replies received to the various questionnaires, as there are many cases where these furnaces are used on red brass. There are said to be several hundred induction furnaces in service today and quite a fair proportion are operating on high-copper mixtures. Contrary to the impression which would be gathered from the paper, several of these furnaces use chrome-ore mixtures which are formed in place both for the block and the crucible of the furnace. Others use a prefired block either of fire clay or high-alumina composition with a crucible of rammed chrome.

We wish to indorse the idea that high-temperature cements should be studied from other points of view than P.C.E. The P.C.E. should not be used alone as the criterion for the value of high-temperature cements. Refractory brick could not be classed from this standpoint. Silica brick, for example, has a lower P.C.E. than a good first-quality fire brick and yet it can be used in continuous operation at much higher temperatures than the fire brick. One of the oldest high-temperature cements on the market, and at the same time most widely used, has a P.C.E. low enough to condemn it for high-temperature work if its performance checked with its P.C.E. It is nevertheless a fact that it is giving excellent service in many instances and in furnaces operating at higher temperatures than at first would seem possible. This cement has maintained itself to the

present day from a time when many users were condemning high-temperature cement wholesale.

The section of the paper in which Mr. White discusses the crucible type of furnace seems to be particularly valuable. It is evidently written with a real knowledge of this type of service and contains much information of permanent value.

C. F. GEIGER:[1] The author has covered the tremendous scope of his subject so thoroughly that he leaves little room for discussion or added comment, and in general our experience agrees with his.

The importance of the maintenance cement as a factor in both the ultimate life of a brass furnace lining and the actual cost of the lining per melt of brass is emphasized. In one instance, 785 heats were secured from a fireclay lining and only 980 from a silicon-carbide lining. The difference here may be that the fireclay lining is patched frequently, perhaps daily, with a costly maintenance cement whereas the particular silicon-carbide lining may receive little or no patching. This may mean that even though the first cost is lower for the clay lining, the maintenance expense in labor and materials may be so great that the original cost of the lining is re-spent many times. Such occurrences frequently are met in small shops having inadequate cost systems, and Mr. White makes clear that neither first cost nor ultimate life of a lining tells the story of the cost per melt. The efficacy of a super-refractory cement in improving brass-furnace linings is indicated to a degree by the fact that the life being secured from a given clay lining is frequently greatly enhanced by the use of a silicon-carbide cement in the original setting-up of a prefired clay lining.

Overlooking a seemingly minute detail in installing a rammed-in lining frequently means the difference between success and failure. In one instance, the venting of a newly rammed lining, in the manner of a foundry mold, made a successful application in a furnace in which a previous attempt had given very poor results. With the first lining in this particular case, it seems that perhaps the drying out and the initial firing were done so quickly that the rapid formation of steam weakened the lining to an extent not visible but to a degree that resulted in early destruction. The deep and frequent venting used in the second attempt apparently allowed for easy escape of the steam without harmful effects, with the result that a most satisfactory life was obtained.

As the author contends, too much weight has been put upon the P.C.E. value of refractory cements without any regard to such properties as shrink-

[1] The Carborundum Co., Perth Amboy, N. J.

age, elasticity, strength at elevated temperatures, and ability to withstand repeated heatings and coolings.

The consideration of the matter of insulation is of prime importance in brass furnaces and especially in prefired silicon-carbide linings because of the extremely high thermal conductivity of this material.

The illustrations show two furnaces identical except for the linings standing side by side and doing exactly the same work. Starting in each instance with new linings that had previously been completely dried out, these furnaces were subjected to heating-up tests. In this particular work melts were made throughout the day.

The following are the periods required for heating up these furnaces, that listed under first day being the time required after installation of thoroughly dried new linings. (See Fig. 1 (No. 1 and No. 2).)

	Time in minutes	
	No. 1	No. 2
First day (1st heat)	75	165
Second day (1st heat)	70	100
Second day (2nd and subsequent heats)	50	23

On the days following, the time was the same as that for the first and second heats on the second day.

Another example, from a different field, illustrates the inadvisability of using insulating material in furnaces under temperature for only short periods. Figure 2 (No. 1) shows the wall of the original furnace

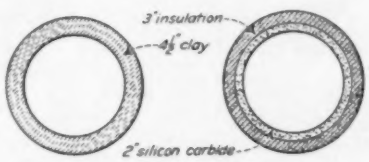

FIG. 1.—No. 1 (left). No. 2 (right).

FIG. 2.—No. 1(left). No. 2(right).

while Fig. 2 (No. 2) shows the supposedly improved design. These furnaces were used for heat treating, running one heat per day.

The furnace in Fig. 2 (No. 1) required the burning of fuel for two hours. The gas was then shut off to perform the particular heat-treating job involved. The furnace in Fig. 2 (No. 2) maintained a lower shell temperature, but it was 40% more costly to operate because at the temperatures required and the rate of firing employed, more heat was taken up as thermal capacity of the lining of No. 2 than was lost through the shell of No. 1 (Fig. 2).

Whether or not, therefore, insulation should be applied to small intermittently fired furnaces depends largely upon the time of firing to be employed as well as upon the thermal capacities of the lining materials and the surface heat losses under the temperatures and gradients to be encountered.

The author refers to the care necessary in placing insulation in the Ajax-Wyatt furnace, due to the danger of shrinking the insulating material. Presumably this refers to diatomaceous earth heat insulators and not to the new refractory insulating materials made from kaolin of which there is at least one product on the market that would probably prove successful in this application.

JOHN A. KING:[1] The author points out that silicon-carbide mixtures are ideal for brass melting furnaces in many ways and are used extensively. Results with the prefired linings are found to be superior to those obtained from rammed linings, but it is to be doubted whether or not they will prove more economical. First, the prefired lining costs considerably more than a rammed lining and the heat loss is also greater. One would naturally suppose that the heat loss would be the same after the furnace was actually in operation, but the rammed lining is actually vitrified only about one and one-half to two inches back and the green mix behind this serves as an effective insulator. With the same thickness of prefired and rammed lining and the same amount of insulation backing up the lining the shell would be much hotter with the prefired lining.

A word of caution should be given on the use of silicon-carbide cements in Detroit electric melting furnaces. While they are being successfully used in many places they are liable to cause trouble where high lead alloys are being melted. It has been noted on alloys containing over 3% lead that a white surface coating of lead silicide is formed, together with an increase in silicon in the casting and a resultant poor crystal structure. On other alloys the silicon-carbide cements have been satisfactory. This trouble in the Detroit furnaces is undoubtedly responsible for the decrease in silicon-carbide cements and the increase in the alumina-mullite cements in the electric furnaces as shown in the author's tables.

The author's criticism of the advertised properties is well taken and some of the glowing advertisements would seem to indicate that a particular cement was a cure-all of every refractory problem. The writer can see no place for silicate of soda in a high temperature cement and recalls a paper by M. C. Booze which showed that a marked lowering of melting point resulted from the addition of a few per cent of silicate of soda.

There is another type of furnace that has come into use in the non-ferrous foundry that shows a great deal of promise. This is the Cushing cupola type furnace, which is being handled by the Barrett Company and is sometimes called the Barrett cupola.

This furnace was developed by Daniel Cushing to be used with a pure

[1] The Carborundum Company, Worcester, Mass.

high carbon coke which is made from coal tar pitch by the Barrett Company. In general appearance it resembles the cupola for melting iron and incorporates original features, one of the chief differences being that it uses a much smaller volume of air and at lower pressure. This air blast is shut off during noon hour and other standby times and there the tuyères are made solely of refractories.

It has been found that silicon-carbide linings are by far the most satisfactory for the tuyère zone and the zone for fifteen inches below and above the tuyères, and the walls above this are fire clay as is the special drop bottom. The furnace is particularly designed for melting composition and bronze alloys.

While one or two installations have successfully used rammed linings the prefired blocks have met with generally better acceptance. To refer to the author's point of the necessity of insulation, it should be stressed here in order to maintain the high temperatures and to keep the fuel ration down as the fuel is expensive.

H. E. WHITE: The author wishes to confirm the fact that the data in this paper are confined to the nonferrous foundry industry. Rolling mills have not been taken into consideration; several aluminum foundries, however, and practically all of the large ones are included.

Regarding the use of chrome refractories, very few cases have been encountered using this material except in the Ajax-Wyatt furnace. The use of chrome refractories in open-flame furnaces has not been particularly successful and since writing this paper one case has come to light where such an installation in an open-flame furnace was ruined due to the reduction of iron in the chrome ore.

There seems to be some question as to the status of linings for the Ajax-Wyatt furnace. The discussion revealed the fact that prefired rings are being experimented with for the upper part of the furnace with a prefired block for the wedge, or if not prefired, they are at least formed outside of the furnace and dried before installation. Magnesia, chrome, and kaolin base refractories are evidently strong competitors in this field.

Referring to mention of the Barrett-Cushing cupola, this was not discussed due to the fact that it is relatively new and undoubtedly very limited in its scope. Up to the present time it has replaced the rocking-arc type electric furnace and the open-flame furnace for production work. The same cautions should be observed in selecting linings for this type of furnace as for the open-flame and electric.

FORMING PRESSURE OF DRY-PRESSED REFRACTORIES. PART I[1]

The Effect of Pressure Variations on the Properties of Green and Dry Bodies

By Raymond E. Birch[2]

ABSTRACT

Making use of a hydraulic press which presses standard fire brick, eight commercial mixtures were investigated to determine the effect of varying the forming pressure. To obtain pressures higher than those used commercially it was necessary to reduce the moisture content. The bulk density of unfired brick is shown to have increased directly with the pressure, as did the transverse strength. These changes, however, are lessened at the higher pressures. By comparing the green bulk density of brick formed on commercial, mechanically actuated presses, with those pressed hydraulically at known pressures it is concluded that industrial forming presses are operated at comparatively low pressures. Fireclay bodies do not attain a state of maximum compressibility within the limits of the study but continue to contract with additional pressure.

Introduction

The dry-press process of manufacturing refractories has rapidly gained favor in recent years. The ware has been constantly improved by better selection and blending of clays, improved grinding and tempering systems, more dependable and more durable presses, and by advance in the knowledge of firing the product. Due to the increasing excellence of these refractories there has been a steady displacement of the output by other processes. This is especially true in Ohio, where at present more than a score of mechanical presses are being operated.

Notwithstanding the splendid progress in manufacturing methods, the effect of forming pressure in dry pressing has been little investigated. Exact data concerning this factor as well as moisture content are not available to the manufacturer of fire brick, the press manufacturer, or the consumer. In view of the importance of the subject and the lack of dependable information, a thorough investigation of the effects and functions of forming pressure was undertaken.

This report deals only with the properties of the unfired ware, and is based on the data accumulated in the first phase of the investigation. Other reports to be published later include the effect of pressure variations on such fired properties as resistance to spalling and slag action, fired porosity, and capacity for load bearing.

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[1] Published with the permission of the Director of the Engineering Experiment Station, the Ohio State University, Columbus, Ohio. Presented at the Annual Meeting, American Ceramic Society, Toronto, Ont., February, 1930 (Refractories Division). Received November 2, 1929.

[2] Research Engineer, The Ohio State University Clay Products Experimental Plant, Roseville, Ohio.

Refractory Bodies

The tests were made on eight commercial dry-press mixtures, supplied by Ohio refractories firms. Their compositions (see Table I) varied from

TABLE I

DATA CONCERNING BODY COMPOSITION AND PREPARATION

Body notation	A	B	C	D	E	F	G	H
Plastic clay	100	60	75	90	91	25		100
Semiflint clay						75	25	Extremely
Flint clay		40	20				75	siliceous
Grog	Trace		5	10	9			
P.C.E.	19	32	29	29	29	31–32	30	26
Orig. moisture	7.25	9.5	10.9	9.6	13.35	8.75	6.6	7.18
Final moisture	5.86	9.5	8.64	7.18	8.6	6.74	4.67	4.69
Screen analysis				Dry screen analysis				
On 8		1.80			1.25	1.25		
10	12.00	12.80	0.8	10.10	13.50	16.25	0.50	1.00
14	17.05	19.15	9.50	14.75	17.50	19.75	1.75	8.75
20	12.65	16.00	14.15	12.05	13.00	13.50	4.75	13.00
28	9.15	15.75	15.80	11.65	11.50	11.50	8.75	17.00
35	9.90	7.25	14.45	9.80	9.00	9.00	10.50	15.75
48	8.50	7.90	9.50	6.80	6.50	6.50	11.50	12.50
65	8.30	5.45	10.40	5.80	5.25	5.50	12.75	10.00
100	6.25	4.10	9.90	8.75	6.25	5.50	14.50	10.05
150	4.60	1.50	4.60	6.30	3.75	3.00	7.50	4.50
200	2.10	0.50	3.30	3.85	3.00	2.50	7.00	2.75
Through 200	8.00	2.30	7.90	9.00	10.00	6.00	24.75	4.00

those mixtures composed almost entirely of plastic clay to combinations of wholly flint and semiflint clays. Their refractoriness covers the range from cones 19 to 32. Body preparation varied considerably, especially in regard to the method of tempering the mixtures. The samples (1000 pounds) were taken from the plants at the point of supply to the press, and therefore were commercial bodies both in regard to composition and preparation.

Equipment

Hydraulic Press The brick were formed in a hydraulic press (see Fig. 1) which attains a maximum pressure of 6000 pounds per square inch, with brick pressed on the flat, which was the case in this study. With edge pressing, a unit pressure of 10,000 pounds is available. Only a single brick is pressed at an operation. The pressure may be hydraulic or hydro-pneumatic if it is desired to speed the cycle by using compressed air. Hydraulic pressure alone was preferable in this study because of the increased ease of observation.

The control valve may be set for any maximum pressure, which when

attained is held automatically until the operator desires to release it. A gage gives a continuous indication of the total pressure.

In filling the die, the mixture of clays is allowed to fall into the mold and is struck off even with the top. A steel plate fits into the mold and is made secure by rolling the male die into place. The female die or mold into which the clay is fed becomes floating when the frictional attachment of the brick becomes sufficient to lift it. This motion produces an effect analogous to that of having the upper die plate move downward, and therefore the clay mass is compressed by forces from both top and bottom.

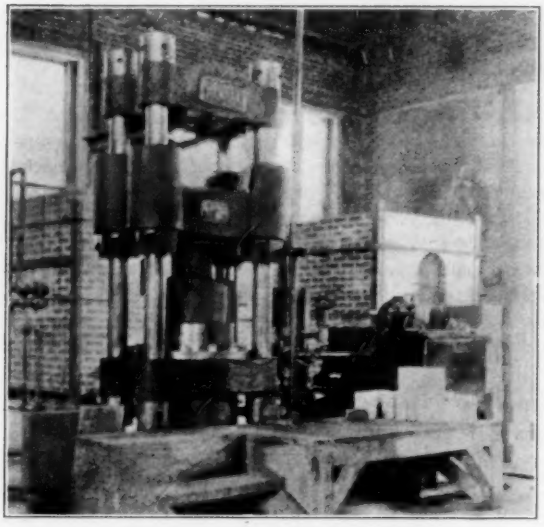


FIG. 1.—The hydraulic press.

Since the top face of the ram forms the bottom of the mold, its position when the mold is filled with clay, determines the thickness of the brick. This position at filling is held constant when desired by placing a steel block under the head of the ram.

Cross-Breaking Machine

Determinations of transverse strength were made by breaking whole brick on the flat, with an eight-inch span. The machine, designed by Everhart, incorporates refinements of the apparatus described by MacGee.[3] Originally intended for breaking only one-inch bars, a larger saddle was supplied which spans the $4^1/_2$-inch face of a standard fire brick. (See Fig. 2.)

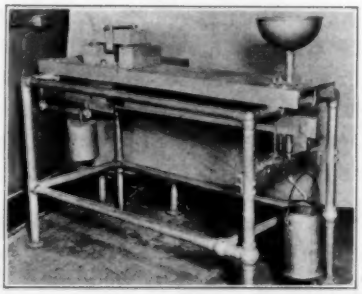


FIG. 2.—The cross-breaking machine.

Procedure

In the investigation of the unfired bodies, brick were to be formed at

[3] A. E. MacGee, *Jour. Amer. Ceram. Soc.*, **10**, 571 (1927).

pressures varying from 500 to 6000 pounds per square inch. The following properties were determined: (1) dry screen analysis, (2) moisture content, (3) bulk density of green and dry brick, and (4) modulus of rupture of green and dry brick.

Pilot Tests For a preliminary study, samples of dry-press mixtures from two plants were brought to the Station in sealed carbide cans. It was found to be impossible to approach 6000 pounds per square inch without the appearance of severe pressure cracks on the side of the brick. Attempts were made to correct the fault by altering the speed and other variable factors in the operation of the press, but these were without appreciable effect. Further tests revealed that by slightly lowering the water content of the bodies, the pressure attainable without cracking was increased. Only slight drying was necessary to give satisfactory brick at the high pressures.

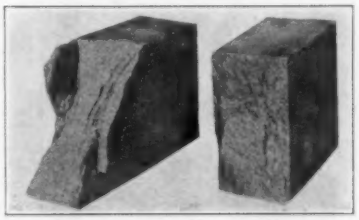


FIG. 3.—Brick of the H series. The specimen on the right is unfired, and exhibits no exterior cracks, despite the presence of interior planes. Only a slight increase in forming pressure would be necessary to produce pressure cracks. The half brick at the left was prepared with the same pressure but has been fired to cone 3.

Preparation of Bodies Half-ton samples were brought from each of the plants. If it was found that the body cracked at high pressures the entire batch was placed on a hot floor where it was slowly dried. In order to keep the water content evenly distributed the clay was constantly agitated. At frequent intervals brick were pressed and the drying process was stopped as soon as the ware, formed at a pressure of 5550 pounds per square inch, showed no pressure cracks. After each clay was thus adjusted it was returned to the containers. About three hundred pounds of each body was trucked to the plant which had supplied it. Arrangements were made to press brick at the Station and at the plant on the same day.

This ideal procedure was varied in some slight particulars with several mixtures, due to the excessive amount of clay required to follow these plans. Thus with bodies A, E, F, and H, drying proceeded farther than necessary and some water was re-supplied with an atomizing gun. The mixture from plant H responded to this treatment only to the extent of forming good brick at maximum pressure of 3540 pounds per square inch. With no moisture content in the dry pressing range could this limit be exceeded.

Mixture B was the first one pressed at the Station, and when it gave the singular performance of forming good brick at the highest and lowest pres-

sures, but with pressure cracks occurring at pressures between 1350 and 3100 pounds per square inch, no attempt was made at moisture adjustment.

A very unusual circumstance was encountered in working with mixture G. The water content, originally 6.6% was decreased to 2.1% and then raised to 9.3%, but attempts to press brick within this range invariably resulted in pressure cracks above 3100 pounds per square inch and sometimes at lower pressures. In order to study the problem further a second batch was obtained from the plant. Since it was received dry, moisture was added with the atomizer to a content of 4.67%. Good brick resulted over the entire pressure range. The investigator was unable to explain the contradictory behavior of these two batches. Of course, there are daily variations in the composition of commercial mixtures, but other than these, the only noticeable differences in the two samples are to be found in the means of moisture addition, and in slight variation of the proportions of various grain sizes.

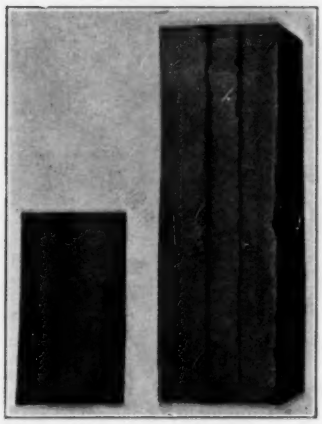


FIG. 4.—An extreme case of pressure cracking with body G;* an edge and a cross-section are shown.

With two mixtures, plant pressing succeeded that at the Station by two days. Investigation revealed that a delay of as much as two weeks produced no noticeable fluctuation in the raw body properties determined.

Determination of Plant Pressures The measurement of pressure in a mechanical press is difficult to accomplish. Indirect means are available, however, and the best of these is probably the comparison of the green bulk density of brick formed in a mechanical press, with the density of test brick from the same clay batch pressed hydraulically at known pressures. In this study, the weights and measurements of brick, pressed at the several plants on mechanical presses, were supplied by the plant superintendents. The same body was pressed hydraulically at the Station.

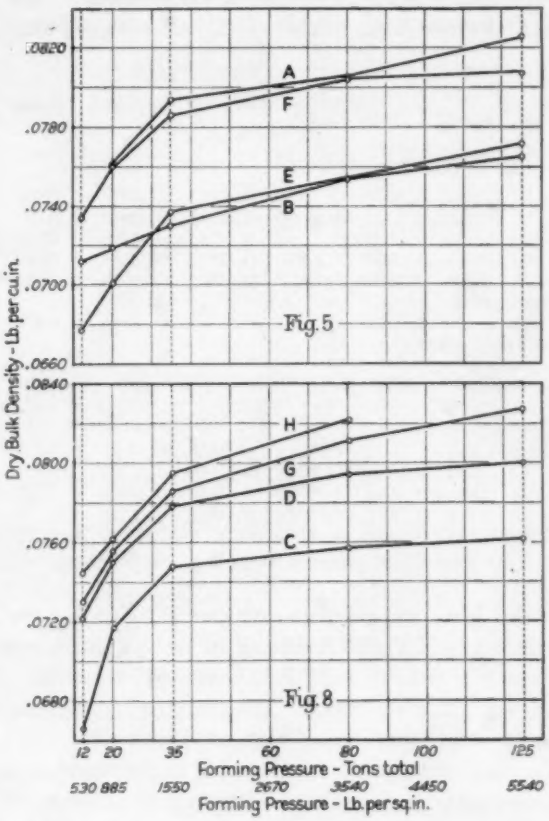
Pressing the Brick At the plants the press was allowed to run empty; the sample was placed in the feeder tubes and pressing began. In view of the decreased moisture content, the pressman had been advised to begin with a pressure higher than that normally

* Pressure cracks as ordinarily observed are more irregular than these. The faults approach a straight line with finer grinding.

used. Some pressure adjustment was necessary to obtain brick free from cracks and having good mechanical properties.

At the Experiment Station fifteen bricks were pressed at each of the following total pressures: 12, 20, 35, 80, and 125 tons. The equivalent unit pressures are 530, 885, 1550, 3545, and 5540 pounds per square inch. Immediately after pressing, each brick was weighed to the nearest gram on a torsion balance. These data, with the linear measurements, supplied figures necessary for calculating the green bulk density.

Transverse Strength Green transverse strength was determined by breaking two brick formed at each pressure. The same number of pieces was dried to constant weight at 110°C, cooled in a desiccator, and broken for dry transverse strength. The weights and linear measurements of these brick supplied the data for dry bulk density and moisture content determinations.



FIGS. 5 AND 8.—The relation of forming pressure to the dry bulk density of the bodies.

The eleven remaining brick of each pressure series were trucked to the coöperating plants to be fired with the ware pressed from the test batch on their commercial presses. After firing they were returned to Roseville for testing.

Results

Bulk Density of Green Bodies The response of the factory mixture from plant A when pressure is applied is typical of all the plastic bodies in the study, the greater the pressure the

greater the density of the brick. Contraction of the material proceeds, however, in smaller increments at the higher pressures. Increasing the forming pressure from 12 to 125 tons adds slightly more than a pound to the weight of the brick of standard thickness.

The greatest density increase with increased pressure was obtained with bodies C and E. The heaviest brick of the entire investigation are those formed from mixture G at 125 tons pressure. The least contraction

TABLE II

BULK DENSITY OF DRY AND GREEN BODIES

Pressure* Tons total	Lbs./ sq. in.	A	B	C	D	E	F	G	H
		Green bulk density (lbs./cu. in.)							
12	530	0.0770	0.0779	0.0717	0.0762	0.0728	0.0774	0.0778	0.0782
20	885	0.0791	0.0800	0.0764	0.0800	0.0757	0.0803	0.0792	0.0796
35	1550	0.0824		0.0792	0.0830	0.0788	0.0833	0.0817	0.0829
80	3545	0.0853	0.0820	0.0822	0.0846	0.0820	0.0854	0.0856	0.0859
125	5540	0.0856	0.0827	0.0826	0.0850	0.0829	0.0858	0.0862	
Plant pressing		0.0820		0.0727	0.0786	0.0712	0.0757	0.0798	0.0809
Indicated plant pressure (lbs./ sq. in.)		1470		610	650	<530	<530	1035	1150
		Dry bulk density (lbs./cu. in.)							
12	530		0.0712	0.0665	0.0722	0.0677	0.0734	0.0730	0.0745
20	885	0.0762	0.0719	0.0718	0.0750	0.0701	0.0760	0.0755	0.0761
35	1550	0.0794	0.0730	0.0748	0.0779	0.0737	0.0787	0.0786	0.0795
80	3545	0.0805	0.0754	0.0757	0.0794		0.0804	0.0812	0.0822
125	5540	0.0826	0.0765	0.0762	0.0800	0.0772	0.0808	0.0828	

* Area on which pressure is applied is 45.0 sq. in.

of the body occurs with mixture B, with the entire increase in pressure from 12 to 125 tons resulting in only a little more than one-half pound of added weight. Bodies D and F resemble A in their reaction to pressure applications. The mixture designated by H apparently is composed of material of high specific gravity. The ware pressed from this siliceous body at 12 and 80 tons is denser than that pressed at the same pressures from the other materials in the investigation.

The green density data are given numerically in Table II and by graph in Figs. 6 and 11. Other than the marked response to change in the lower half of the pressure range, the most striking observation is the retarded effect at the top pressures.

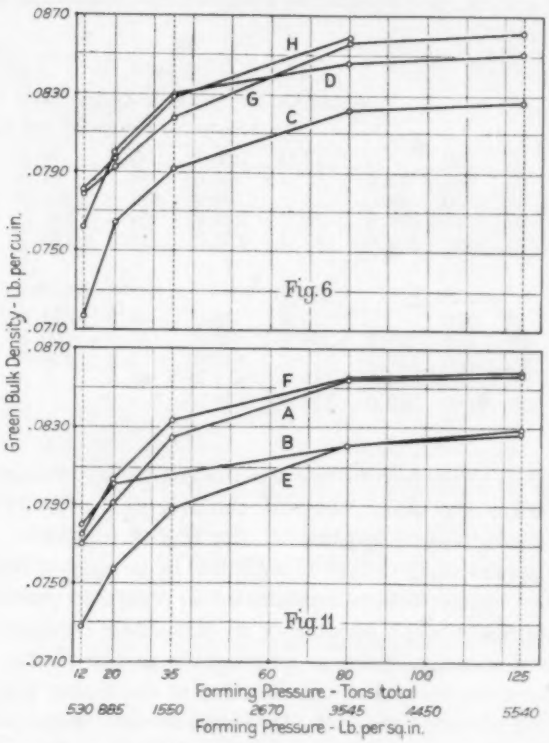
Commercial Pressures Comparisons of the green density of the plant pressed brick with those formed at the Station are made in Table II. The outstanding observation is that industrial pressing resulted in densities which fall within the 12- to 35-ton pressure range and even lower. The average pressure effect obtained in the plant pressing as indicated by these data was about 850 pounds per square inch. It should be understood that these figures refer to pressure effect

rather than to actual pressures, as the time factor and method of applying the load is different in the mechanical press.

Bulk Density of Dry Bodies

In general the relations which exist between pressure and green bulk density are likewise existent for pressure and dry bulk density. The latter property, however, is a better means of comparing the densities of different bodies. With an average of 7.0% water driven off in drying the brick, and with the very slight drying shrinkage which occurs in dry-press bodies, it was to be expected that all values for dry bulk density should be lower than the corresponding green body figures. In general, the total increase in dry bulk density, due to increase in the forming pressure, is slightly less than is the case with the green brick series.

The results reveal one reversal of this general relationship. Body G, which had an increase of only 9.75% in green bulk density increased its dry density by 11.85% within the same pressure range.



FIGS. 6 AND 11.—The relation of forming pressure to the green bulk density of the bodies.

The salient facts to be noted in summarizing are that dry bulk density increases directly with pressure increase and that the zone of greatest action occurs in the lower half of the pressure range investigated.

Transverse Strength of Green Bodies

The transverse strength of green bodies is shown to increase greatly with pressure increase. Within the pressure range examined, an increase in modulus of rupture of 300% was common and twice that change was accomplished with two bodies. The clay from plant A is representative of the high plastic mixtures. They increase in strength up to the 80-ton

series and give retarded action at higher pressures. This latter phase may indicate the development of internal strains due to the presence of laminations. The modulus of rupture of body B was least responsive to change in the forming pressure. The fact that almost half of the entire increase occurs between 12- and 20-tons pressure and the lack of response to pressure above the 80-ton series are notable.

The modulus of rupture resulting from pressure variations with bodies C, D, E, and F agree to a remarkable degree, as may be seen in Table III.

TABLE III

MODULUS OF RUPTURE OF GREEN AND DRY BODIES

Green modulus of rupture (lbs./cu. in.)

12	530		37.0	24.4	30.6	24.9	29.6	20.6	27.0
20	885	35.4	61.4	43.6	50.1	43.6	44.6	29.8	39.3
35	1550	49.6		74.2	71.8	71.6	79.2	43.1	60.5
80	3545	105.0	86.0	129.0	109.0	119.3	105.2	71.2	97.2
125	5540	119.0	87.3	175.0	118.3	140.5	113.5	82.6	

Dry modulus of rupture (lbs. /cu. in.)

12	530		75.8	30.6	64.3	49.0	58.2	54.0	79.9
20	885	96.3	104.7	75.3	143.0	100.7	120.2	79.8	96.0
35	1550	151.7		125.0	173.8	188.3	195.0	185.4	175.6
80	3545	335.7	142.4	215.5	305.8		280.0	283.4	225.5
125	5540	346.0	151.9	274.0	278.0		256.0	293.5	

Each of the four bodies benefits greatly by pressure increase over the lower half of the range, but with the exception of body C there is little increase in modulus of rupture at the higher pressures. The green modulus of rupture of the plant C mixture, in increasing from 24.4 to 175.0 pounds per square inch, is unparalleled in regard to percentage change. Body G, naturally weak because of its nonplastic composition, nevertheless attains a percentage increase comparable to the plastic clay mixtures. It, too, becomes comparatively inactive at the higher pressures.

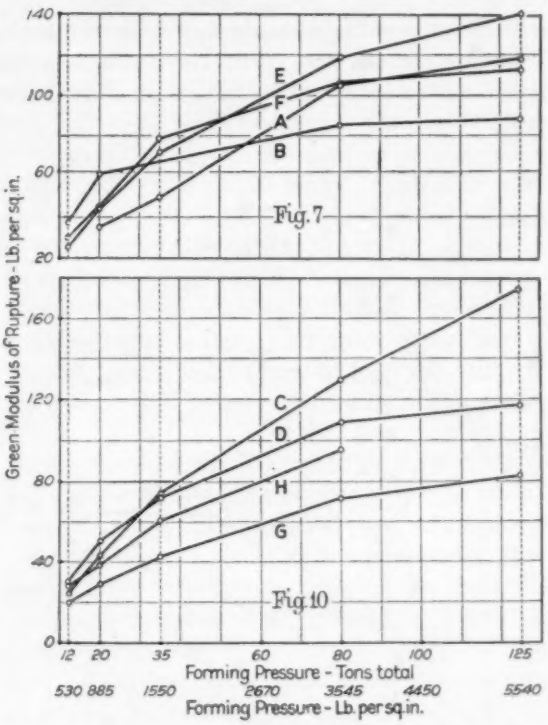
The magnitude of the increase in transverse strength as additional pressure is applied is surprising. Of most practical value is the fact that at the lower pressures (in the indicated zone of present commercial pressing) the bodies are most responsive to pressure increase. Bodies B, F, G, and H[4], which contain the smallest percentages of plastic clay are also weakest in the green state, with F, however, being little different from the plastic bodies.

Transverse Strength of Dry Bodies

The modulus of rupture of the dry brick followed very closely the green body data in regard to the effects of forming pressure. The pro-

[4] Listed in Table I as all plastic, but actually very high in clayey sandstone with very low plasticity.

portional change from low to high forming pressure is predictable from the green strength data, although the strongest green bodies are not necessarily the strongest when dry. As a group the high plastic bodies have little advantage over the mixtures containing nonplastics. The transverse strength of each body increases rapidly over the lower part of the pressure range, as the latter factor is increased. Usually the action is retarded at the higher pressures.



FIGS. 7 AND 10.—The relation of forming pressure to the modulus of rupture of the green bodies.

Body A possesses singularly high strength with a maximum modulus of rupture of 346 pounds per square inch with the ware pressed at 125 tons. The 125-ton series of body F has a lower transverse strength than does the 80-ton series, probably due to the development of laminations in the 125-ton members. The effect of interior planes is likewise apparent with the high pressure series of body D.

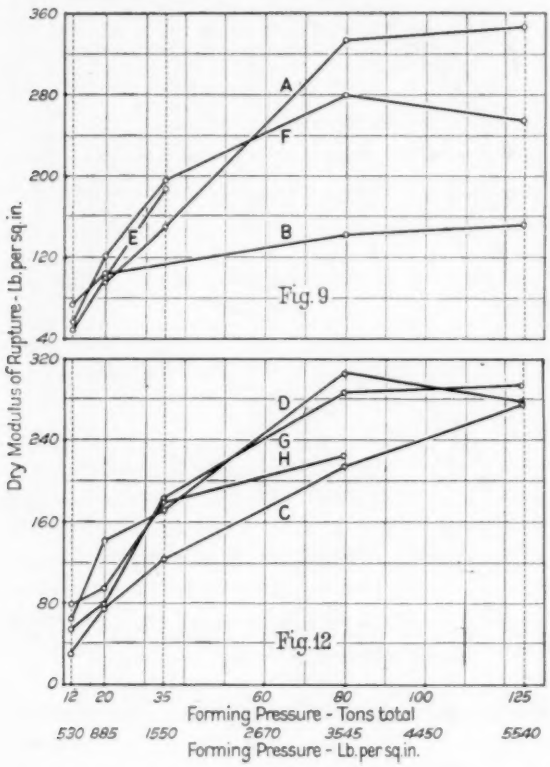
Occurrence of Pressure Cracks

Pressure cracking is the factor which limits the range of successful application of forming pressure. This significant point, and the fact that their appearance is common to commercial pressing as well as to this experimental work, establishes a bench-mark for comparison of mechanical and hydraulic pressing. Examples of pressure cracking are shown in Figs. 3 and 4.

Bodies A, C, and D gave perfect press behavior without the appearance of pressure cracks or laminations. Body B was the only mixture from which perfect brick could be formed at the highest and lowest pressures, and yet with cracking at intermediate pressures. This defect appeared

at 30, 40, 50, 60, and 70 tons, and some difficulty was given by the 80-ton series, although enough good brick were formed for the tests. The pressure cracks in the latter series do not appear to be aggravated by drying the ware.

Bodies E and F developed no cracks, but broken brick showed that the 125-ton members were badly laminated, and the condition was incipient in the 80-ton series. It has been mentioned that body G presented considerable difficulty and that a second sample was secured before pressure cracks could be avoided at high pressures.



FIGS. 9 AND 12.—The relation of forming pressure to the modulus of rupture of the dry bodies.

Body H is distinctive in a discussion of pressure cracking because of the nature of the cracks formed. Instead of occurring near the middle of the faces they appeared at or near the 9-inch edges, and were accompanied by cupped laminae, complementary to each other. In forming the ware, cracking was so severe at 125 tons that the use of that pressure was abandoned in the study of this body. No cracks were apparent at 80 tons but the interior cupped planes were so well developed that striking the flat of the brick resulted in a sound of hollowness. Drying produced cracks along the edges of the brick in this pressure series.

Interpretation

Plant Practice Plant practice in the operation of mechanical dry presses is governed by the belief that more water results in brick of better properties, and especially resistant to spalling.

Our data indicate that by reducing the water content but increasing the pressure, the same good quality of green ware may be maintained. Furthermore, the interchangeability of moisture content and forming pressure changes in eliminating pressure cracks are shown.

Pressure Cracks The appearance of pressure cracks in the manufacture of brick from plastic clays is the factor which is most instrumental in holding the forming pressure within limits. To begin with, the press operator knows when the body is properly tempered by the "feel." When the mixture is properly prepared it is just possible to cause the clay to bond together by squeezing it in the hand. Such control is more dependable than might be believed. The investigator's experience and that of manufacturers consulted indicates that the water content at the press usually does not vary more than 1 or 2%. In operating a mechanical press, upon the appearance of pressure cracks the pressure is reduced. When pressure cracks appeared in the brick formed at the Station the same policy of pressure reduction could have been followed, but the investigation would have been limited to pressures probably not in excess of 1500 pounds per square inch.

Commercial Pressures The green bulk density data indicate that industrial forming pressures give pressure effects equivalent to the hydraulic pressing at pressures not over 1500 pounds per square inch. Full recognition is given to the prevailing opinion that the commercial pressing range extends several times higher. For example, Bales[5] says that the pressure required for making dry-pressed brick is about 4000 pounds per square inch for soft plastic clays and about 6000 pounds per square inch for flint clays. Flood[6] writes in 1922 that the pressure at times is about 5000 to 6000 pounds per square inch and the former figure is assumed by Hager and Flood[7] quite recently. It is assumed that these writers are expressing their opinions only, since they do not describe their method of pressure determination.

The data presented in this paper show no greater pressure effects with mechanical presses than those obtained hydraulically at 1500 pounds per square inch but of course do not prove that higher pressures are not available with these present presses. Time is a factor of some importance in the application of pressure. It is to be regretted that the characteristics of the experimental press do not permit completion of the pressing operation in so brief a period as do the mechanical presses. With the hy-

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[5] C. E. Bales, "The Manufacture of Dry-Press Brick by the Dry-Press Process," The Ohio Ceram. Ind. Assn., *Bull.*, No. 5.

[6] L. W. Flood, "Dry Pressing Refractory Shapes," *Brick and Clay Rec.*, **61**, 855–56 (1922).

[7] Earl Hager and L. W. Flood, "Manufacture and Use of Semidry-Pressed Refractory Brick and Shapes," *Bull. Amer. Ceram. Soc.*, **8** [5], 107 (1929).

draulic press, which was not built to attain the speed now available with commercial presses of the same type, the time required for applying the pressure can seldom be made less than ten seconds. Mechanical presses are often operated with the pressure being applied in about a third of that time. Since a lengthier period of pressure application results in brick of greater density, it is a probability that commercial pressures are some higher than our data indicate. Considerable evidence, however, seems to suggest that the maximum pressure available with continuous operation is not far above the limit indicated. For example, at plant H, as the test brick were formed the press was brought to a stop at each pressing with the full pressure in effect. It was held for a few seconds and then the operation was completed. Thus the highest pressure allowed by the usual press adjustment, in addition to such ample time, resulted in ware of a density which indicated a forming pressure of less than 1200 pounds per square inch. At plant F, the pressure effect was much lower, but the foremen stated that the highest pressure allowable with continuous operation was used.

In a mechanical press four bricks are normally pressed at a time. To obtain additional information, a special brick was pressed at plant G, by filling only one mold with clay, so that it received the full pressure. Then this brick was hammered back into the mold and additional clay was added. Pressure was then applied several times but the clay would not compress sufficiently to allow completion of the pressing cycle. Enough clay was then chiseled from the top of the brick to permit completion of the operation, with extrusion of the brick. Following are complete data concerning the green bulk density of this body pressed at the Station and at the factory as described.

Forming pressure (lbs./sq. in.)	Dry bulk density (lbs./cu. in.)
530	0.0730
885	0.0755
1550	0.0786
3545	0.0812
5540	0.0828
Special plant brick	0.0836

If we consider that the rate of compression between 3545 and 5540 pounds per square inch continues above the latter pressure, the dry bulk density of the special brick indicated a forming pressure of 6540 pounds per square inch. It should be emphasized that in the pressing operation, a single brick was receiving the total pressure normally applied to four bricks. We thus again have a confirmation that the maximum pressure attained with the mechanical press is about 1500 pounds per square inch.

Compressibility Limit Hager and Flood,[7] in regard to clays reaching a maximum compressibility, say

Furthermore, any plastic material will require only a certain amount of pressure to

give it its maximum compactness and any more pressure will be useless. It has been proved that a substantial mechanical machine will press to the limit on either of these materials.[8]

While the first statement is correct in theory, such compactness cannot even be approached in mechanical presses, under continuous operation. It is probable that contraction would continue much higher than the pressures investigated, due to the shattering of clay particles. This point is to be cleared up in future tests at 10,000 pounds per square inch, by edge pressing brick from the same clay mixtures.

Plant Proving An interesting point brought out is that higher forming pressures can be used if the moisture content of the body is reduced. Attempts at plant adaption, however, should be carefully controlled. The average reduction in moisture content in this work was only 2.0%, but this alteration increased the maximum pressure (without pressure cracks) from about 1000 to about 5500 pounds per square inch. It is a question whether commercial presses are being operated close to their maximum efficient pressures. If so, any drying must indeed be slight if the tests may be undertaken with hope of success.

Conclusions

(1) The bulk density of dry and green dry-pressed brick increases with increase in forming pressure, the greater increments of increase being at the lower pressures.

(2) The transverse strength of dry and green dry-pressed brick increases with increase in forming pressure, the greater increments of increase being at the lower pressures.

(3) The data indicate that the pressures attained in commercial presses (mechanical) are low, and much below that previously assumed.

(4) Pressures above the present commercial range may be employed (without developing pressure crack) by utilizing lower moisture contents than those now used.

(5) Only slight increase over commercial pressures is necessary to obtain very substantial improvement in the green strength of the ware, and marked density increase.

(6) Within the limits of this investigation, the dry-press bodies may approach, but do not reach a condition of maximum compactness, beyond which additional pressure produces no further density increase.

Acknowledgment The author expresses appreciation for the advice and assistance given by the Refractories Research Committee of the Ohio Ceramic Industries Association. Appreciation is equally felt for the thorough coöperation given by the manufacturers in making the plant tests.

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[8] Nonplastic and plastic materials.

THE CAUSES AND PREVENTION OF BULGING IN HAND-MOLDED REFRACTORY SHAPES†

By Gordon B. Richardson

ABSTRACT

Bulging is a universal problem in the manufacture of large refractory shapes. It is discussed from the standpoint of molding, pressing, turning from the mold, drying, edging, firing, and air and gas pockets.

Introduction‡

When large refractory shapes, such as cement-kiln liners, are hand molded there is a tendency for one side to bulge and the bulging always takes place on the same side. The side that causes trouble is the one that is on top when the piece is in the mold and on the bottom when the piece is turned on the floor to dry. This side is called the "cut face" and will be referred to as such in this paper. Although the bulge can be seen when the block is in the dry state, it is far more pronounced after the block has been fired.

The problem of bulging is a universal one and many refractory plants in the country have had trouble with it. Only one reference has been found in ceramic literature, either American or foreign, that gives any explanation of this bulging, the possible causes of it, or means of prevention.[2]

Manufacture of Hand-Molded Fireclay Shapes

At a large firebrick plant, near Seattle, the clay body used for hand-molded refractory shapes consists of a mixture of 80% Washington fire clay and 20% grog. The grog and nonplastic content is essentially a mixture of coarse-ground, flint fire clay and ground-up bats, culls, and seconds.

The grog content was determined from two separate batches, two samples being taken from each. The samples were blunged by hand, allowed to settle, and the water decanted. This operation was continued until the decanting water was clear. The nonplastic content was dried and a screen-analysis made of it. The first two samples were taken from a regular batch obtained at the plant, the last two from a sample pugged in the Ceramic Laboratory. The results of these screen analyses are found in Table I.

The preparation process consists of dry-pan grinding, followed by tempering in a pug mill, and then storing until used. The blocks are dried

† A portion of a thesis submitted as a partial requirement for the degree of Bachelor of Ceramic Engineering, University of Washington, Seattle. Received September 28, 1929.

‡ For footnotes in this paper see Bibliography on page 271. Footnote references correspond to numbered references in this Bibliography.

in the tunnel drier after standing in the molding room until they attain a movable condition.

The blocks are set in the kiln twelve courses high. It is customary to set the blocks on top of fire brick. Eight days are required to fire the blocks; a maximum temperature of 1240 to 1270°C is reached, which

TABLE I

SCREEN ANALYSIS OF NONPLASTIC CONTENT

On mesh	Sample 1 (%)	Sample 2 (%)	Sample 3 (%)	Sample 4 (%)	Average (%)
3	0.38	0.16	0.00	0.00	0.13
4	1.69	2.19	0.00	0.00	0.97
6	8.12	6.33	1.40	2.02	4.47
8	8.78	9.05	3.95	3.74	6.40
10	10.20	10.33	7.65	8.43	9.15
14	8.65	8.38	8.25	8.48	8.44
20	7.22	6.93	7.25	7.60	7.25
28	7.93	7.89	8.30	9.79	8.48
35	8.10	8.47	10.25	10.75	9.44
48	10.80	10.17	11.15	11.74	10.96
65	6.20	6.95	6.75	7.54	6.86
100	3.83	5.14	10.50	9.40	7.22
150	7.08	8.09	8.80	9.16	7.88
200	6.18	5.05	7.80	7.54	6.64
−200	4.96	4.85	8.20	4.67	5.67

brings cone 12 down on top and cone 11 down on the bottom. The firing schedule starts at 60°C and rises 20° every two hours and forty minutes up to 600°C, where it is held for twenty-four hours to oxidize the ware completely. After the twenty-four hour period the kiln continues to rise at the rate of 20°C every two hours and forty minutes until the settle or shrinkage starts around 1100°C. From that point the temperature is raised faster, depending upon the rate of settle, until cone 12 is brought down on top.

The blocks at the top of the kiln will be fired harder and will show a darker color than those at the bottom. It is hard to say whether or not bulging will be greater in the blocks at the top than in those on the bottom. The test blocks were placed in the top of the kiln.

Preliminary Tests in Ceramic Laboratory

Purpose The clay used in the manufacture of special shapes was tested according to the specifications set forth by the Committee on Standards, AMERICAN CERAMIC SOCIETY. The purpose was to determine the effects of various methods of molding on the shrinkage and strength of the clay. The clay had been ground and pugged at the plant and had no further treatment in the laboratory except the molding.

Methods The methods of molding and marking are explained in the following paragraphs. All the bars were marked for shrinkage while in the plastic state.

Series A_1: These bars consisted of 8-inch standard bars made on a small auger machine in the laboratory. The clay was run out in strips one inch in cross-section, and was cut to 8 inches in length.

Series B_1: These bars were made in the standard mold 8 by 1 by 1 inches, the clay being pounded in by hand with all the force possible.

Series C_1: These were made in the same way as the bars of series A_1. While in the plastic state they were stretched lengthwise as far as possible without causing the bar to crack or rupture. This increased the length but decreased the cross-sectional area. Shrinkage marks were applied after the bars had been stretched.

Series D_1: These also are the same as the A_1 series except that they were compressed after being cut into 8-inch lengths. This was done by placing the ends of the bars between two boards and then pressing the board together without rupturing the body. Shrinkage marks were applied after the blocks had been compressed.

Series A_2: These were small bars made in the same manner as the A_1 series except that small, 2-inch bars were cut in place of 8-inch bars. Both plastic and dry data were obtained on all the small bars.

Series E_2: These consisted of small bars, made in a dry-press brick machine under great pressure. The same data and measurements as in series A_2 were obtained.

TABLE II

DATA ON STANDARD 8-INCH BARS*

Series no.	Dry linear shrinkage (%)	Total linear shrinkage (%)	Dry transverse strength (lbs./sq. in.)	Fired transverse strength (lbs./sq. in.)
A_1	3.3	6.0	154.3	729.0
B_1	3.3	5.8	163.6	1063.5
C_1	4.8	7.0	274.8	1131.0
D_1	3.3	6.0	135.5	985.0

* Average results of data obtained on 15 bars for each series.

Results on 8-Inch Bars The results from this set of experiments indicate the effect of pressure used in the molding on the shrinkage and transverse strength. Except for the transverse strength, the variations in results are far more noticeable in the fired data than in the dry. The A_1 series, made in the auger machine, and the compressed or D_1 series, gave the same results on both the dry and fired shrinkage. The stretched bars, the C_1 series, showed the highest shrinkage in both the dry and fired states. Bailey,[1] performing the same experiments, obtained results which indicate the same conclusions. When the clay bar is stretched, more plastic shrinking material is brought between the grog grains in the line of shrinkage.

Results on Small Bars There was no great difference between the results of the small test pieces in the A_2 series and those in the E_2 series. The A_2 series consisted of bars made in the auger machine; the pressure was applied on the ends as the clay was forced through the

die. The E_2 series was made under a higher pressure, which was applied on the top rather than on the ends.

The data indicate that increasing the pressure lowers the ratio of shrinkage to pore water (0.516 to 0.326) together with shrinkage water and

TABLE III

DATA ON STANDARD SMALL BARS*

Series no.	Water plasticity (%)			Shrinkage water (%)			Pore water (%)		
	Min.	Av.	Max.	Min.	Av.	Max.	Min.	Av.	Max.
A_2	18.10	18.30	19.65	3.57	6.02	8.47	9.75	11.64	14.98
E_2	16.74	17.34	18.04	3.69	4.00	4.31	12.05	12.27	12.50

Series no.	Dry volume shrinkage (%)			Fired volume shrinkage (%)			Apparent porosity (%)		
	Min.	Av.	Max.	Min.	Av.	Max.	Min.	Av.	Max.
A_2	6.78	8.04	8.80	9.30	11.18	14.35	25.20	27.05	28.00
E_2	7.12	7.74	8.36	9.75	11.64	14.98	28.55	30.10	31.45

* Thirty test pieces were used in the A_2 series and 10 in the E_2 series.

dry-volume shrinkage. The results show that the pore space, in both the dry and fired condition, was higher in those bars that received the higher pressure.

The lack of difference between the results of the two series can no doubt be accounted for by the various facts that influence the work. Variation in the water content of the clay, as the various tests were made, tends to give results that are not uniform. The rate of drying has been given by some authors as one of the causes of variation, but variation in water content is a more important factor.[3,7] Slight differences in heat treatment due to location in the kiln, and other procedures in laboratory practice cause differences in results.

Summarizing the laboratory tests, it can definitely be stated that the amount of pressure and the method of molding, which cause irregular pressure, have much to do with the amount of shrinkage and the transverse strength in both the dry and fired state.

Method of Measuring Bulge

To study the bulging of hand-molded blocks it was necessary to devise some method of measuring the amount of bulging. Various methods were used and discarded until the following was tried and decided upon. Bulging was determined by placing a straight-edge upon one corner and pointing it across to the opposite corner, then measuring the distance of the straight-edge above the latter corner. In order to get accurate results it is necessary that the straight-edge be firmly placed at the starting corner and held so that there is no tendency to rock. The four corners and the centers of the four sides on each block were measured, making

sixteen measurements for each block. In some cases where the amount of bulging on one side was great, the opposite side showed a depression instead of a bulge. The average measurement for each block has been calculated, along with the total dry and fired measurements for each batch of blocks. For aid in interpreting the results the following comparisons should be noted: an average measurement of 0.30 inch or more constitutes a bad bulge; 0.20 to 0.30 inch a medium bulge; 0.10 to 0.20 inch a slight bulge, and 0.10 inch and less a very slight bulge or no noticeable bulge. Due to irregularity on the surface, practically no blocks are free from bulging when measured by this method.

Tests Made at the Firebrick Plant

Purpose in General The problem presented by bulging and the definition of bulging have been briefly discussed in the foregoing pages. In order to study this problem from all angles it was necessary to watch blocks made under commercial conditions and in the same manner as those giving the trouble. Several tests were therefore conducted at the firebrick plant mentioned.

The first tests at the plant were made with the purpose of determining what effect molding, drying, and firing have on bulging.

The second tests were made with various theories in mind regarding the cause of bulging and to see the effect of various conditions on the blocks themselves.

Batch A Purpose The blocks comprising Batch A were made by the hand molder at the plant. These blocks were made for the purpose of examining the method of manufacture and the treatment the blocks received during the process of operation.

Methods These blocks, five in number, were made in a wooden mold, 9 by 9 by 6 inches in size. The "special-shapes clay mixture," described in the introduction was used. The same mixture was also used in making the small test pieces.

After being pressed and turned from the mold, the blocks were allowed to dry on the molding-room floor until in the leather-hard condition. The blocks were then loaded on drier cars and sent through the tunnel drier, after which they were placed in a round, downdraft periodic kiln and fired to cone 12.

Results and Summary

Block 1	Average bulge after drying	0.285
	Average bulge after firing	0.460
Block 2	Average bulge after drying	0.245
	Average bulge after firing	0.445
Block 3	Average bulge after drying	0.246
	Average bulge after firing	0.498

The average of all the blocks in the dry state was 0.269 inch compared to

0.437 inch for the fired. The bulge, according to the measurements, had almost doubled during firing.

Batch B Purpose The blocks comprising Batch B were made for the purpose of determining the effect of air pockets formed during molding.

Methods and Results These blocks were molded by different methods, partially dried on the cement floor of the pressing room, completely dried on the regular drier cars in the tunnel driers, and fired to cone 12 in a round, downdraft, periodic kiln.

Block 1 was molded in the regular fashion, similar to those in Batch A. This block was slightly bulged after drying and had a medium bulge after being fired. The average bulge after drying was 0.11 with 0.276 for the measurement after firing.

Block 2 was molded with a deep air pocket in the center of the body and about $1^1/_2$ to 2 inches from the top or bulging face. This air pocket was made by pushing the back of the hand into the plastic clay and then covering the pocket over with a second piece, fixing it so that there was no outside opening to the pocket. This block was mediumly bulged upon drying and badly bulged upon being fired. The dry bulging measurement was 0.19 and the measurement after firing 0.42.

FIG. 1.—Block B6, pressed with two bats on top of which were placed 3 thicknesses of paper about $^1/_2$ inch from the top of the mold. Fresh clay was then thrown on top of the paper and hammered. A bad bulge developed on the face turned to the right, closer to the paper.

Block 3, while in the process of molding, had a sheet of paper inserted in the center and about $1^1/_2$ inches from the top of the mold. A medium bulge appeared after drying and a bad bulge upon firing. The average dry measurement was 0.225 and the fired measurement 0.44.

Block 4 was made in the same manner as Block 3. This block showed only a slight bulge after being dried and a medium bulge after firing. The dry measurement was 0.08, the fired 0.186.

Block 5 was made with two thicknesses of paper inserted about $1^1/_2$ inches from the top side. This block had a slight bulge after drying

and did not change a great deal upon firing. The dry measurement was 0.13, the fired 0.135.

Block 6 had three thicknesses of paper inserted about $^1/_2$ inch from the top of the mold. A medium bulge appeared after drying and a bad bulge appeared after firing. The dry measurement was 0.25, the fired 0.361. See Fig. 1.

TABLE IV

EFFECT OF AIR POCKETS

Batch no.	Dry bulge	Total fired bulge	Method of molding (1 piece of mold)
A Average	0.269	0.437	Regular plant practice
B1	0.11	0.276	Regular plant practice
B2	0.19	0.42	Empty air pocket
B3	0.225	0.44	One sheet paper
B4	0.08	0.186	One sheet paper
B5	0.13	0.135	Two sheets paper
B6	0.25	0.361	Three sheets paper

The results of Batch B also indicated that bulging practically doubles after the blocks are fired. The average in the dry state was 0.162; this average increased to 0.303 in the fired state. The blocks in which paper had been inserted were on the average badly bulged and the bulge was more noticeable after firing than before. This may be indicative of the action of gases. The insertion of the paper gave two-fold results: (1) It gave an excellent opportunity to follow the flowage of the clay during molding, as well as (2) the harmful effect of lamination planes in the block. The ash left by the paper could be clearly seen when the fired blocks were cut into sections. The ash had taken on the shape of an arc of a circle. The nearer the paper had been inserted to the top of the mold, the greater was the curvature of the arc. Pictures of the ash in the blocks are shown in the accompanying photographs.

Batch C

Purpose

Batch C, consisting of 26 blocks, was made with the object of investigating theories in mind as to the causes of bulging and also to see the effect of various manufacturing practices, such as the effect of various methods of molding, turning the mold, edging, drying, and firing. Blocks 2 and 3 were made with paper in them to see if placing the paper nearer the bottom of the mold had an influence on the amount of bulging.

Methods and Results

In the other tests made at the firebrick plant the blocks were molded in a one-piece, wooden mold, 9 by 9 by 6 inches. When the block is being removed from this mold the clay drags along the sides. This movement causes the center to move first, while the sides and particularly the corners are retarded. This step in the process of manufacture is the second one to cause bulging in the block. The bulge is partially removed or straightened by the opera-

tor who presses the bottom of the mold on the freed block, standing on the floor, and thereby brings the block again to squareness.

In order to remove this source of trouble and possible cause of bulging, a new mold was constructed with removable sides. The outside part of the mold was identical with the old mold except that it was larger in both width and length. Four boards cut to fit the inside of the mold were inserted to form the removable sides. The clay was thrown in the inside of this new four-board interior and the block made. When the block was removed the four inside walls slipped out, sliding along the sides of the mold. The clay itself did not slip or slide at all against the mold. After the block had been removed to the drying floor, the four boards, which were not fastened, were stripped off, and the block, now perfectly square, was ready for drying without the usual deformation. This second mold will be designated as the 5-piece mold.

FIG. 2.—Block C2, a badly bulged block which had been loaded with a paper separator to show the pressure planes. The face turned away to the right is the bulged side.

Some of the blocks of Batch C were made in the new mold and others, for comparison, in the old one-piece mold. This gave an excellent opportunity to see if removal of the block was a factor in the bulging. The first ten blocks were turned completely over after twenty-four hours to hasten and facilitate the drying. All the blocks were dried for two days on edge, that is, on one of the 9- by 6-inch sides, before being loaded on the cars and sent through the tunnel driers. The blocks were dried in the drier for twelve days and then the dry measurements were taken. They were then placed in a kiln and fired to cone 12.

A description of the method of molding and the results for each block follow:

Block 1: Molded in the five-piece mold. Three bats of clay were used to form this block. No bulge was formed on removal from the mold. This block was badly bulged after firing and when cut into sections the three bats of clay used in its molding could clearly be seen. The average dry measurement was 0.254 and the fired 0.40.

Block 2: Molded in two sections with paper inserted in the center, two inches from the bottom. Molded in the 5-piece mold. This block also was badly bulged. When cut, the bottom half peeled off, and in doing so left a perfect imprint of the paper in the form of ash. Dry measurement 0.22, fired measurement 0.386. See Fig. 2.

Block 3: Molded in two sections with paper inserted in the center of the block, halfway from the bottom. Molded in the 5-piece mold. This block had a medium bulge and when broken gave the same kind of a fracture as Block 2. Dry measurement 0.14, fired measurement 0.225.

Block 4: Molded in the 5-piece mold in one solid piece. The mold was bounced and hammered before the excess clay was cut off and the block removed. This block gave only a very slight bulge, a fact that gives proof of the advantage of using the mold with removable sides, and also molding in one piece. No measureable bulge after drying and a bulge of 0.09 after firing.

Block 5: This block was made in a similar manner to that of Block 4, except that it was made in the old one-piece mold. This block had no measureable bulge and also showed the effect of molding in one piece.

Block 6: Similar to Block 5, but molded in two sections. This block was badly bulged and shows the results of molding in sections. Dry bulge 0.29, fired bulge 0.43.

Block 7: Molded in the one-piece mold but fine-grained, digester-block clay was used. On account of the extreme fineness of grain, difficulty was encountered in removal from the mold.

Block 8: Similar to Block 7 except that it was molded in the 5-piece mold.

Blocks 7 and 8, while only slightly bulged, had high shrinkage and also were badly cracked. These two blocks are excellent examples of what a fine-grained clay will do. Block 7, dry bulge 0.20, fired 0.17. Block 8, dry bulge 0.19, fired 0.06.

Block 9: Made in 5-piece mold in two sections. The mold was pounded hard before slickening and removal. This block, like all those made in the 5-piece mold, required no tamping of the corners of the mold to remove the block. This block showed a bad bulge and illustrated the disadvantage of molding in sections. Dry bulge 0.285, fired 0.40.

Blocks 10 to 15 inclusive were made in one piece in the 5-piece mold, and the mold was tamped and hammered before slickening and removing. These blocks showed on the average only a slight or medium bulge and proved the advisability of molding in one piece and with a removable sides mold.

Blocks 16 to 20 inclusive were made in the regular one-piece mold in one piece and the mold hammered before removal. These blocks were also not badly bulged and gave a good comparison to the blocks molded in sections.

Block 21 was made in the regular one-piece mold by slamming in several small wads of clay. The center was pounded with a plank until it became spongy. This block, turned from the mold without the mold being hammered, was badly bulged. Dry bulge 0.21, fired 0.32.

Block 22 was molded by first building up the sides and then throwing the center in last. No pounding in the center was done but the mold was hammered before the top was smoothed. This block was made in

the old one-piece mold, and was rather badly bulged showing the result obtained by molding in sections. Dry bulge 0.22, fired 0.28.

Block 23 was made in the 5-piece mold. The mold was half filled by building up the sides and center. The sides were then hammered with a plank until the center rose. The mold was then completely filled by throwing in one large piece of clay with no hammering. Dry bulge 0.18, fired 0.27.

Block 24 was made in the regular one-piece mold and in the reverse method of Block 22. The mold was hammered before removal. This block showed the start of a good bulge when removed from the mold but was only slightly bulged later. Dry bulge 0.14, fired 0.17.

Block 25 was molded in the 5-piece mold, the sides of the mold being oiled instead of grogged. This block was only very slightly bulged. Dry measurements 0.01, fired 0.08.

Block 26 was unique in its method of molding. Small wads of clay about the size of a man's fist were rolled out and then covered with grog. These were thrown into the mold and tamped into place without excess pressure and without knitting the various wads too closely together. This block was mediumly bulged. Dry measurement 0.17, fired 0.24.

TABLE V

RESULTS OF "C" SERIES

No.	Drying bulge	Total bulge after firing	Type of mold	Remarks
C 1	0.254	0.40	5-piece mold	3 bats used
2	0.22	0.386	" "	2 bats, paper 2 in. from bottom
3	0.14	0.225	" "	2 bats, paper in middle
4	0.00	0.09	" "	1 bat, well tamped
5	0.00	0.00	1-piece mold	1 bat, well tamped
6	0.29	0.43	" "	2 bats
7	0.20	0.17	" "	Fine-grained digester clay
8	0.19	0.06	5-piece mold	" " " "
9	0.285	0.40	" "	2 bats, well tamped
10	0.20	0.22		
11	0.17	0.08		
12	0.22	0.23	5-piece mold	1 bat, well tamped
13	0.186	0.21		
14	0.084	0.07		
15	0.22	0.18		
16	0.23	0.26		
17	0.15	0.18		
18	0.19	0.25	1-piece mold	1 bat, well tamped
19	0.18	0.23		
20	0.15	0.18		
21	0.21	0.32	1-piece mold	Numerous small bats, tamped well in center only
22	0.22	0.28	" "	Separate sides and center, light tamping
23	0.18	0.27	5-piece mold	Separate hammered sides, untamped center
24	0.14	0.17	1-piece mold	Reverse of Block 22
25	0.01	0.08	5-piece mold	Oiled sides
26	0.17	0.24	Fist-sized grog-covered bats used with light tamping	

TABLE VI

DATA ON USE OF BOTH MOLDS WITH VARIATION IN THE NUMBER OF BATS

Two or more bats				Single bat			
No.	Drying bulge	Total bulge after firing		No.	Drying bulge	Total bulge after firing	
A 1	0.285	0.460		C 4	0.00 (min.)	0.09	
2	0.245	0.445		5	0.00	0.00 (min.)	
3	0.246	0.498 (max.)		10	0.20	0.22	
B 1	0.11 (min.)	0.276		11	0.17	0.08	
C 1	0.254	0.40		12	0.22	0.23	
2	0.22	0.386		13	0.186	0.21	
3	0.14	0.225		14	0.084	0.07	
6	0.29 (max.)	0.43		15	0.22	0.18	
9	0.285	0.40		16	0.23 (max.)	0.26 (max.)	
21	0.21	0.32		17	0.15	0.18	
22	0.22	0.28		18	0.19	0.25	
23	0.18	0.27		19	0.18	0.23	
24	0.14	0.17 (min.)		20	0.15	0.18	
26	0.17	0.24					
Av.	0.214	0.343		Av.	0.152	0.167	

TABLE VII

DATA ON DIFFERENCE BETWEEN THE FIVE-PIECE MOLD AND THE SINGLE-PIECE MOLD USING A SINGLE BAT

5-piece mold		Single-piece mold	
Drying bulge	Total bulge after firing	Drying bulge	Total bulge after firing
0.00	0.09	0.00	0.00
0.20	0.22	0.23	0.26
0.17	0.08	0.15	0.18
0.22	0.23	0.19	0.25
0.186	0.21	0.18	0.23
0.084	0.07	0.15	0.18
0.22	0.18		
Av. 0.154	0.154	Av. 0.15	0.183

Summary of the Results of Batch C

(1) Most blocks increase in amount of bulging upon being fired.

(2) Blocks molded in one piece give less bulging than those made in sections. (This is not in accord with recent tests made at the American Refractories Institute.*) See Fig. 3.

(3) Blocks in which lamination planes were artificially produced in most cases gave a larger bulge.

(4) Very little difference was found in the bulging of blocks made in the 5-piece and one-piece molds when a single bat was used for both molds.

(5) The finer the clay the greater the shrinkage and cracking.

General Observations on the Causes of Bulging

Experiments indicate that bulging is not always due to the same cause, but may arise from any one of several causes. Bulging may be caused or

* Stuart M. Phelps, "Report of Technical Dept., Amer. Refractories Institute for the Year 1928–29," *Special Bull.*, August (1929).

increased by the method of manufacture or by the type of clay used. The following causes of bulging have not only been deducted from the experiments and tests made in this study but also from the general experience and observation of the various methods used in the manufacture of large refractory shapes.

The Clay Mixture

The clay used is a factor in the cause of bulging. It is a well-known fact that the finer the clay and grog content the greater the shrinkage. Thus when bulging takes place in a body with a high percentage of fine grog, the bulge in most cases will be larger and more pronounced than in a body with a high percentage of coarse grog and, therefore, a lower shrinkage. The part shrinkage plays in the cause of bulging will be discussed later.

It is possible that clays containing a high content of organic material and heated too fast through the water-smoking and oxidation periods will be more inclined toward bulging than those more free from such impurities.

Uniformity of the clay batch is still another important point. The clay mixture used should be uniform in regard to the proportion of each constituent and the equal distribution of all components including clays, grog, and water or those factors which affect shrinkage.

FIG. 3.—A badly bulged block made with two bats. On splitting the fired block, the outline of the two bats is revealed. The bulged side is in the rear.

Uneven Pressure in Molding and Lamination

As explained before, large refractory blocks such as those made in these tests are usually molded in sections or bats. The bottom and sides are built up first and the center thrown in last. Two and sometimes three wads of clay are used to make a single block. This molding in sections offers good opportunities for the formation of lamination planes, holes, and gas pockets. Bulging is not only started by the formation of lamination planes but also, in this method of molding, by the harder pounding that the bottom layer receives. This has been shown by the experiments with paper inserts and by following the flowage of clay during the molding. Less shrinkage takes place vertically in high-pressed clay than in loosely-pressed clay. While the block is still in the mold it is not uncommon to find the top center in a rather spongy condition in

contrast to the hard, dense structure of the bottom. Thus we see that uneven pressure and molding in sections offer two favorable conditions for formation of a bulge in later operations.

Removal of the Block from the Mold After the block has been molded, the removal is accomplished by inverting the mold and then tamping the corners on the floor in rotation, which causes a loosening of the clay from the sides. The mold is then lifted upward and the block slides out. It is often necessary to lift the mold and block completely off the floor and shake the mold in order to loosen the block. When shaking is done the center of the block will be seen to move first and the sides and corners last. This flowage of the clay may be one of the causes of the concentric circles seen in sections of fired blocks. When the block is entirely out of the mold it resumes the square shape, but it may have been disturbed or strained to such an extent to cause a bulge at a later stage of the process.

Uneven Drying The side that was on top during molding is the side on which the block rests while drying, and is the one on which the bulge will form. The trouble starts during the first 24 or 48 hours. As soon as the blocks are stiff enough they are turned completely over so that the side which was first on the floor is now on top. The blocks will not be in a condition to be turned over until after 24 or 48 hours of drying. From the study made at the firebrick plant this period is the critical point for the formation of a bulge.

The rate of evaporation is most rapid at the beginning of the drying period. This fast evaporation takes place from five of the six faces, first on the surface and then gradually working in toward the center. The face that lies against the floor does not have the same chance to dry as do the others. When the outside faces appear to be perfectly dry the center and bottom face may still contain a high percentage of moisture. Thus the shrinkage takes place first on the five exposed sides, and last on the sixth or bottom side. As shown before, this bottom side may be less dense or compact than the top side and have a greater shrinkage. The corners on such blocks tend to lift, leaving the bottom face convex. The depression on the upward face, that is, the one opposite to the bulging face, is similar to that formed on the finished faces of terra cotta. This condition can be explained by the irregular shrinkage. On the pieces where the corners turn up, the top edges, drying first, become stiff and rigid, while the center dries last and produces a measurable depression. This change of shape is probably brought about during the early stages of drying.

Setting and Firing Large refractory blocks are set in a kiln at this firebrick plant on top of fire brick, and are set twelve courses high. No particular care is taken as to which side the block is

set on. If the blocks are set so that the cut side is down, without much space open about it, trouble may ensue in the firing period. Bulging or change of shape without cracking can only take place during a period when the clay is in a water-plastic or pyroplastic condition.

Suppose a block is set with the trouble-causing side downward and the block is not entirely free from moisture when set. The firing schedule is figured for blocks perfectly dry and in this case it would be too fast for the semi-wet block. Steam is generated within the block during water-smoking and is confined mainly to the area close to the cut surface. The softened side as already shown, is also the least compact portion and therefore may be easily bulged or floated as the steam forces its way out. A clay body having a high percentage of water of chemical combination could also be bulged with steam.

Bulging due to escaping gases could also take place with a clay having a high organic content. During the oxidation period gases form and collect in the lamination planes and gas pockets. As they force their way out through the easiest route, which is through the cut face, they may form a bulge. High-temperature volatile gases escaping during the vitrifying, pyroplastic period are also likely to cause the same trouble.

If a block has started to bulge before coming to the kiln, firing conditions will in many cases enlarge the bulge.

It is possible that the bulging may be decreased during the last stages of firing by setting the dry block on the bulge formed during drying. Sagging of the corners may straighten the block.

Prevention of Bulging

The prevention of bulging in hand-molded fireclay shapes lies in control of the various manufacturing operations. In the lack of uniformity of the raw material itself lies one of the primary causes of bulging. A grog-clay mixture may give trouble in some batches of blocks but not in others. This uncertainty is due to possible variation in the original clay and not to variations in the final clay-grog mix. To meet this situation care in the uniform choice of clay is foremost in importance.

Care must be taken in selection of the clays as they come from the pit or the mine, and for one complete job as uniform a supply as possible should be obtained. The nonplastic content should be regularly checked and the mix should not contain an excess of fine grog. Fine grog causes increased shrinkage and through that condition an enlargement of bulging, should any appear. Care should be taken that the grog of a clay body prepared in a wet pan is not ground too fine.

Molding and drying of the blocks require the most attention, and control of these two processes should be emphasized. The blocks should be molded in one large piece and not in sections, as described under the heading of

causes. The mold should be sanded or greased according to the design and size of the mold, and then a large wad of clay, approximating the required size, which has been rolled in grog, should be thrown in with as great force as possible. The mold should then be tamped on the floor or molding table until the clay structure is uniform. The excess clay is cut off with a wire and the exposed surface smoothed over with a trowel. The excess clay should be placed on the molding table with the grog side down. This practice prevents any grog from getting in between clay layers and preventing good adhesion or knitting when a new wad is made. Poor knitting is liable to cause lamination planes, gas or air pockets, and affords chances for bulging during the water-smoking or oxidation periods.

Removing the blocks from the mold without causing deformation requires good technique which is obtained only through practice. For ease in this operation and to insure against possible deformation, a slip mold is recommended. By use of a mold in which the sides slip out, the block is not subjected to any strains that might cause bulging. Tamping the mold, as explained in the preceding paragraph, loosens the block and allows it to be removed without difficulty. To aid in turning the blocks during the drying period, the blocks should be dried on boards or pallets containing holes.

It is in the molding and drying of the blocks that the greatest chance for bulging occurs, and it is in these two processes that the greatest elimination can be obtained. The drying of the blocks cannot be overstressed; it should be done carefully and not rushed. After the blocks have stood on the drying floor for twenty-four hours or more, depending on the clay, they should be turned through an angle of 180°. If bulging has been a serious trouble the blocks should be turned again, after twelve hours, through an angle of 90°. This turning of the block enables drying of all the faces to take place more uniformly. As soon as the blocks are hard enough they should be loaded on cars and sent to the drier. It should be remembered that these blocks are considerably larger than ordinary fire brick and require a longer period for complete drying to take place. Upon removal from the drier the blocks should be set as soon as possible and not allowed to stand in any place where they are likely to take up moisture. If a hot drying floor is used in place of a cold concrete floor the danger of bulging during early stages of drying would be lessened.

Care must be exercised in setting the blocks in the kiln. It is common practice, where quantity is overemphasized, to set the blocks without preference to the setting face. It is thought that the blocks should be set on one of the faces at right angles to the one that bulges and with ample space between the blocks for complete air circulation, although it is recognized that sagging may help eliminate some bulging in the vitrification

period. The water-smoking and oxidation periods are important and the ones in which trouble is likely to appear. The rate of firing should be figured from the type of ware being fired, and ample time allowed for both water-smoking and oxidation. Under no condition should blocks be set in the kiln before they are completely dry.

Conclusion

Bulging is a universal fault of large, solid masses of clayware and the underlying causes and prevention of it have been treated from the standpoint of molding, pressing, turning from the mold, drying, edging, and firing. The molding and drying of the blocks are the two most critical steps in the process and too much emphasis cannot be laid on these operations. Complete elimination of bulging may not be possible, but by careful control of the various steps of manufacture, the percentage of bulging in hand-molded shapes can be reduced to a minimum.

Acknowledgment The writer is greatly indebted to the personnel of the company at whose plant the work on this study was conducted. The help, guidance, and revision of the manuscript by Hewitt Wilson has been of the utmost value as well as the helpful criticism of Dean Milnor Roberts.

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OPACIFYING EFFECT OF SOME FLUORIDES IN ENAMEL MILL ADDITIONS[1]

By R. Melville Pearce and R. M. King

ABSTRACT

This paper describes the results of a study of the effect of barium fluoride and zinc fluoride on enamels when added in the mill. These fluorides were used with high silica, high borax, high lead oxide, and high antimony oxide enamels. The effect of these fluorides upon opacity and the creation of such defects as crawling and crazing are shown by triaxial diagrams and photographs.

Introduction

This paper presents the results obtained from a study of the opacifying effect of some fluorides. These results were entirely negative in the work here described. They are of value to those who are interested in the action of fluorides in enamels.

Cause of Opacity Opacity is generally regarded as being due to a large difference in index of refraction between the glass or enamel, and the opacity producing agent which is suspended in it, although the latter agent may, in itself, be a transparent material. The agent is finely ground and well mixed throughout the glass so that the light, carrying the image of the material behind the glass, is thoroughly diffused and thus no image is carried through to the eye.

Fluorides as Opacifiers The best opacifying agents in use today are very expensive and none of the substitutes are particularly satisfactory. It is generally recognized that fluorides produce some opacity in enamels when added to the raw materials before smelting. Possibly they would develop even more opacity if added with the mill addition. The theory is that if the opacity is due to the fluorine and if part of the fluorine is driven off in the smelting, the full effect of the fluorine as an opacifying agent could be secured by adding the fluorides to the enamel after the smelting process.

Barium fluoride and zinc fluoride were the fluorides tried. It is reported from Europe that these salts were used as opacifying agents, being added raw in the mill batch.

The Investigation

The tests were run on Armco 20-gage steel pieces 2 by $3\frac{1}{2}$ inches. All the firing was done in a small electric furnace and all the frits were prepared by smelting in a pot furnace. The steel was prepared for enameling by the usual cleaning, pickling, and neutralizing solutions. A good ground coat was chosen and used throughout.

[1] Presented at the Annual Meeting, American Ceramic Society, Toronto, Ont., February, 1930 (Enamel Division). Received January 9, 1930.

To determine the effects of the fluorides upon a variety of enamels, four enamels were chosen, one high in silica, one high in borax, one high in lead, and another containing antimony oxide. The lead enamel was a cast-iron enamel and was used upon small cast-iron pieces covered with a good dark blue cast-iron ground coat.

The high borax enamel was fired at 1540 to 1580°F for the first coat and at 1460 to 1500°F for the second coat, both firings ranging from 2 to $2^1/_2$ minutes.

The high silica enamel was fired at 1550 to 1600°F for the first coat and at 1500 to 1550°F for the second coat with a time range of from $3^1/_2$ to 5 minutes.

The high lead enamel was fired at 1420 to 1450° and at 1380 to 1420° for $3^1/_2$ to 4 minutes.

In the case of the antimony oxide enamel used, the antimony oxide was added before the smelting and as a result was too opaque for making any observations upon the opacity derived from the fluorides. It will, therefore, be eliminated from discussion in the rest of the paper.

After fritting, the enamel was ground with all the mill additions except the opacifiers.

To try out the effects of the fluorides in a systematic manner and to have definite standards for comparison, the opacifying mill additions were added upon the basis of a 15-member triaxial system with the enamel containing 8% tin oxide in one end member, 16% barium fluoride in another end member, and 16% zinc fluoride in the third end member. Thus the tin oxide decreased in 2% intervals and the fluorides in 4% intervals.

In this way a maximum opacity was secured by the 8% tin oxide composition and a minimum opacity for the enamel under consideration was secured by firing two pieces containing the enamel without any opacifying addition. The latter pieces, however, were fairly opaque due to the effect of the fluorides used in the smelting and the clay added in the milling.

Detail Results

High Borax Enamel This was a very good appearing enamel. Composition 1 (8% SnO_2) had a smooth, bright, opaque surface with no defects. The bright smooth surface was retained all through this study but the opacity began to decrease slightly as the amount of tin oxide was reduced and the fluorides introduced. Below Composition 6 (4% SnO_2–8% ZnO_2), the opacity was less than in the pieces fired with the enamel which did not contain any opacifier.

The compositions containing a high percentage of barium fluoride had a circular crawling which resembled the lines of a magnetic field. The zinc fluoride produced a very bad crawling. (See Figs. 1 and 2.)

High Silica Enamel This was a very refractory enamel and the surface had a slight eggshell texture, which in Composition 1 was bright and very opaque. As before, the opacity decreased with the decrease in tin oxide and the addition of the fluorides, but in this case the compositions containing more than 4% of the fluorides had less opacity than the pieces without any opacifier added. In the compositions where no tin oxide was added the enamel was quite transparent. As in the previous case the barium fluoride developed a circular form of crawling, but the zinc fluoride did not cause any crawling and gave a much smoother surface than for Composition 1. (See Fig. 2.)

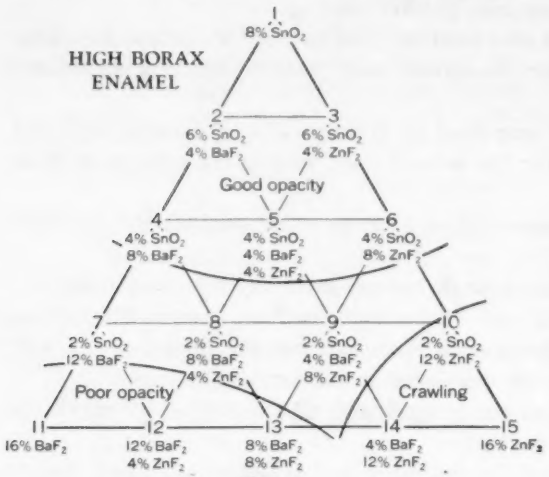
HIGH BORAX ENAMEL
1 8% SnO2
2 6% SnO2 4% BaF2
3 6% SnO2 4% ZnF2
Good opacity
4 4% SnO2 8% BaF2
5 4% SnO2 4% BaF2 4% ZnF2
6 4% SnO2 8% ZnF2
7 2% SnO2 12% BaF2
8 2% SnO2 8% BaF2 4% ZnF2
9 2% SnO2 4% BaF2 8% ZnF2
10 2% SnO2 12% ZnF2
Poor opacity
Crawling
11 16% BaF2
12 12% BaF2 4% ZnF2
13 8% BaF2 8% ZnF2
14 4% BaF2 12% ZnF2
15 16% ZnF2

FIG. 1.

High Lead Enamel This also was a very good appearing enamel having a bright, opaque surface with a slight eggshell texture. (See Fig. 3.) As before, the opacity decreased with the addition of the fluorides but the decrease was slight and did not get below the opacity of the pieces with no opacifier added.

The barium fluoride produced a slight amount of crawling.

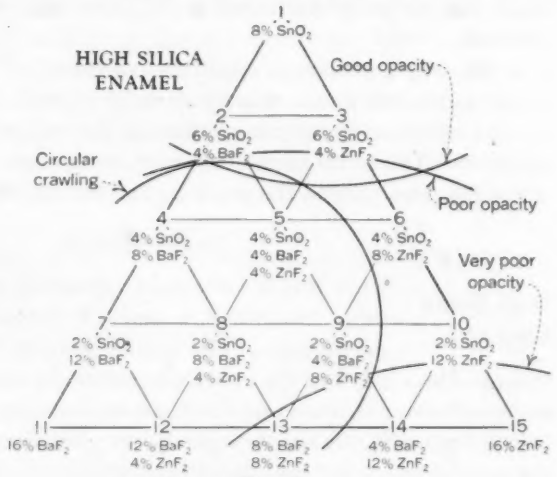
HIGH SILICA ENAMEL
1 8% SnO2
Good opacity
2 6% SnO2 4% BaF2
3 6% SnO2 4% ZnF2
Circular crawling
Poor opacity
4 4% SnO2 8% BaF2
5 4% SnO2 4% BaF2 4% ZnF2
6 4% SnO2 8% ZnF2
Very poor opacity
7 2% SnO2 12% BaF2
8 2% SnO2 8% BaF2 4% ZnF2
9 2% SnO2 4% BaF2 8% ZnF2
10 2% SnO2 12% ZnF2
11 16% BaF2
12 12% BaF2 4% ZnF2
13 8% BaF2 8% ZnF2
14 4% BaF2 12% ZnF2
15 16% ZnF2

FIG. 2.

Conclusions

It was very apparent that the fluorides caused a decrease, rather than an increase in opacity, and this was particularly noticeable in the zinc fluoride corner of the high silica enamel.

To confirm this conclusion, the study was repeated using barium oxide in place of barium fluoride and zinc oxide in place of zinc fluoride. The oxide results were not very satisfactory but gave results which confirmed the conclusion from the first set of experiments.

Since the fluorides seemed to have the greatest effect upon the high silica enamel a series of fusion tests were run by using small cylinders of enamel which were fired from 1000°F to their fusion point at a rate of approximately 14° per minute. These showed a fusion range of from 1580°F for the 16% zinc fluoride composition, to 1620°F for the 16% barium fluoride composition, to 1660°F for the 8% tin oxide composition.

These results supported the previous evidence which indicated that the fluorides, particularly zinc fluoride, have a fluxing action in the enamels, thus increasing their fluidity and consequently decreasing their opacity.

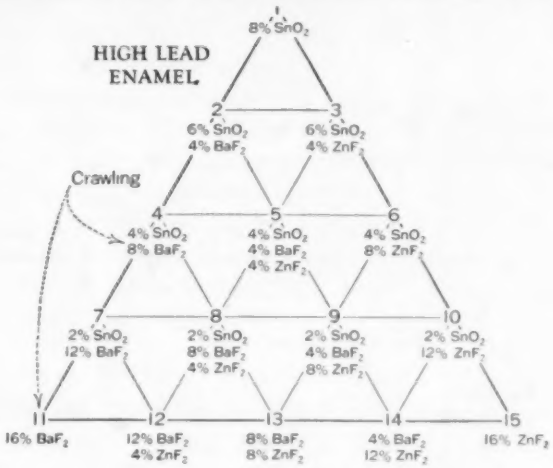

FIG. 3.

Summary

The results show conclusively that fluorides cannot be used as opacifiers, or even as accessory opacifiers, when added to the mill.

The most active results produced by the fluorides were in the high silica enamel study. Here it was clearly shown that their action made the enamel more transparent so that it lost practically all of its opacity. Just exactly what reaction occurred in the enamel is not known but quite possibly the fluxing action of the fluorides caused the whole mass to melt into a homogeneous glass and there were few, if any, minute particles left in the glass such as are necessary to produce opacity by their index of refraction being different from that of the rest of the enamel.

The fact that the effect of fluorides was more evident in the high silica enamel than in any of the others can be best explained by the results of the fusion test. This enamel was fired longer than any of the other sheet steel enamels and the extra time was sufficient to allow the fluxing action of the fluorides to take effect. That there was a fluxing action and that it lowered the fusion point and increased the fluidity was definitely proved by the fusion test.

The high lead enamel on cast iron was also fired for a long time but its temperature of firing ranged from 1360 to 1450°F and was mostly below 1420°F. These temperatures were too low to permit the fluxing action of the fluorides to take effect.

The same tendencies were evident in the high borax as in the high silica enamel, but they were not so pronounced due to the lower firing temperature and the shorter firing time.

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RAW AND WHITE GROUND COAT[1]

By A. Malinovszky

ABSTRACT

The author discusses the possibility of using the mineral lepidolite as a ground coat or enamel. The analyses of several samples of lepidolite are given; their refractoriness and expansion values are also calculated. Being high in Al_2O_3 and containing no B_2O_3 precludes the use of lepidolite in any essential quantities. Lithium oxide of which lepidolite contains about 4% does not aid in adhesion of the ground coat to cast iron. The patented ground coats with their various materials and minerals are discussed. The literature is reviewed and examples of good and defective ground coats are named using composition data and microphotographs to illustrate the essentials for good ground coat adherence.

Introduction

In the last ten years the enameling industry has been profoundly influenced by the rapid development of permanently colored and acid-resisting enamels in raw and white ground coats, and the introduction of many substitutes for tin oxide. Improved methods of smelting in rotary furnaces and the use of electric and tunnel furnaces for fusing the enamel on to the ware have made changes in enameling practice.

A recent patent issued in England in March, 1929, and another in the United States in the same month are of interest.

Part I

The English patent claims the discovery that lepidolite possesses all of the necessary properties, both chemical and physical, of a good enamel, and is also resistant to thermal shocks and to the action of acids.

Lepidolite is very fusible. It is a silicate of potassium, lithium, and aluminum with varying amounts of hydroxyl, fluorine, etc.

The usual forms in which it occurs are like those of muscovite, principally in masses made up of small scales or granules. It varies in color throughout, shades of rose red, lilac, bluish purple, purple, violet gray, and at times, white.

Deposits found in the United States are located in California, Connecticut, Maine, South Dakota, and New Mexico.

According to the patentee, the mineral may be finely ground and without any further mill additions, can be applied directly on the ware without the use of a ground coat, and matured as an enamel by firing to a temperature of 1000°C (1832°F). The lepidolite fused in this manner is said to have a good covering power, color, and gloss; it does not blister or "burn up" if left longer in the furnace, as do the usual fritted enamels. Because

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[1] Presented at the Annual Meeting, American Ceramic Society, Toronto, Ont., February, 1930 (Enamel Division). Received November 20, 1929.

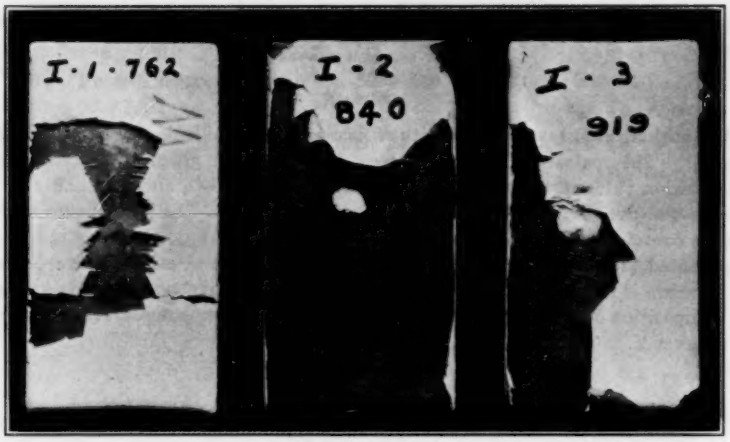

FIG. 1.—All showed good adhesion of the ground coat. Sample I: fritted ground coat without cobalt and nickel. Sample II: fritted ground coat containing cobalt. Sample III: fritted ground coat containing cobalt and nickel.

of its simplicity, the lepidolite (if usable) should be very interesting to anyone engaged in the enameling industry.

The patentees are perhaps correct when steel is the metal base being

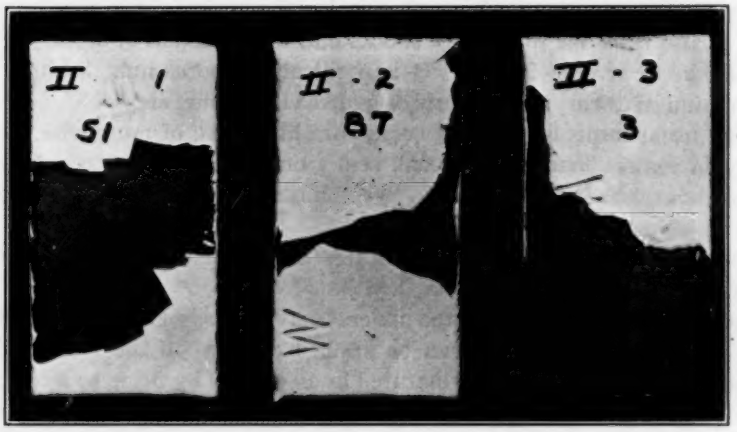

FIG. 2.—Sample I: raw ground coat containing lepidolite. Sample II: raw ground coat containing cobalt and nickel. Sample III: white ground coat fritted containing 0.15 cobalt, 0.15 nickel, and 3 lbs. of antimony oxide. All showed poor adhesion. The iron surfaces are dark as though reduced.

enameled. If the lepidolite is to be used on cast iron the results are quite different.

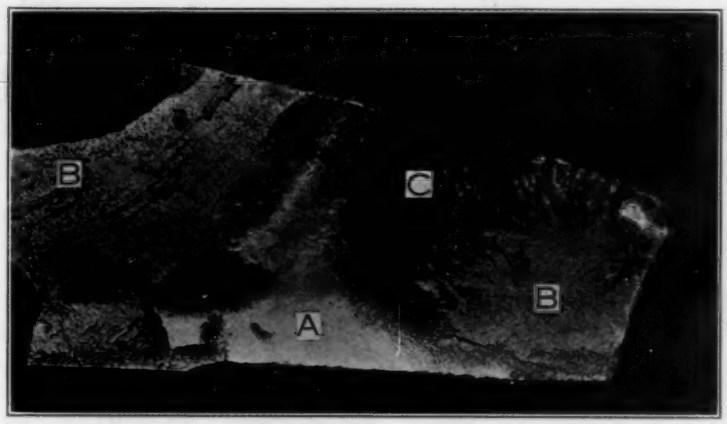

FIG. 3.—From a lavatory in regular production. Ground coat contains cobalt and nickel.

A represents the enamel; *B*, surface of the metal; *C* is the ground coat. Note the angle of which the enamel broke loose. Figure 5 was taken at *C*.

Chemical Analysis

These analyses which are taken from records of the U. S. Geological Survey[2] have been calculated to 100%, omitting the fluorine.

The analyses of a sample of lepidolite from San Diego, Calif., and from

	ANALYSES			
	I	II	III	IV
SiO_2	54.42	53.78	53.55	54.58
Al_2O_3	24.17	25.30	30.55	27.29
Fe_2O_3	0.85	0.87	0.11	0.13
MnO_2	1.43	1.36	0.53	
Li_2O	5.45	4.89	2.54	4.31
Na_2O	2.40	2.52	1.69	1.94
K_2O	11.28	11.28	11.03	10.65
Coeff.	301.706	306.506	312.931	299.179
R. V.	3.67	3.78	5.29	4.52

Embudo, Mexico were made by the author. In addition an analysis is given of one ground coat[3] and one enamel batch.

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[2] Analysis of Rocks and Minerals, Years 1880 to 1914, U. S. Geol. Surv., *Bull.*, No. 591, p. 331.

[3] Homer F. Staley, Bur. Stand., *Tech. Paper*, No. 142.

ANALYSES

	San Diego		New Mexico	
SiO_2	55.14	56.20	60.84	61.61
Al_2O_3	23.89	24.35	23.38	23.62
Fe_2O_3	0.81	0.83	0.32	0.32
MnO_2	1.96	2.00		
CaO	0.60	0.62	0.61	0.62
MgO	0.14	0.14	0.22	0.22
Li_2O	4.56	4.65	1.89	1.91
Na_2O	1.18	1.20	1.16	1.17
K_2O	9.82	10.01	10.39	10.53
F	3.19		2.12	
	101.29	100.00	100.87	100.00
Less	1.34		0.89	
	99.95		99.98	
Coeff.	283.84		276.80	
R. V.	4.14		4.41	

	No. 5 ground coat	No. 5 enamel
SiO_2	67.82	24.58
Al_2O_3	3.80	7.00
K_2O	1.77	6.42
Na_2O	6.66	6.53
B_2O_3	12.13	6.04
PbO	7.50	17.10
MnO_2	0.14	
CoO	0.18	
BaO		5.83
ZnO		6.00
CaF_2		12.00
SnO_2		8.50

$$\frac{\text{Refractory}}{\text{Flux}} = \frac{71.94}{28.06} = 2.56 \text{ R. V.} \qquad \frac{\text{Refractory}}{\text{Flux}} = \frac{59.92}{40.08} = 1.49 \text{ R. V.}$$

For cast-iron ground coat and enamel, lepidolite lacks boric oxide, has high content of aluminum oxide and the alkalis, and has small content of silica.

FIG. 4.—*A* is the enamel; note where the *X* is, how the enamel broke loose (slivery). The black field represents the ground coat, and the gray represents the metal.

Ground Coats

The average refractory value (R.V.) of lepidolite is 3.67 to 4.50, some even 5.29. This would make the ground coat too refractory. The high

content of Al_2O_3 in the coating prevents it fluxing adhesively to the cast iron.

High percentages of Al_2O_3, CaO, and MgO should be avoided in ground coats. Lithium causes poor adhesion and has no covering power and lithium oxide fuses at a low temperature[4] and vaporizes at 100°C.

In an enamel, a high percentage of alumina causes an oily finish, makes the enamel too viscous, and hence uneven in surface after firing. Boric oxide is also very essential.

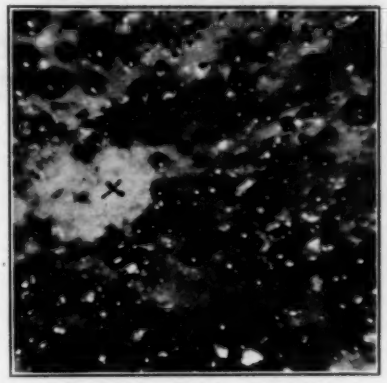

FIG. 5.—Magnified 20 times, *X* and the gray field represent the enamel. These bubbles are seen where the ground coat has the strongest adhesion to the metal.

FIG. 6.—Typical of samples of different manufacturers showing good adhesion of the ground coat. Under the microscope same bubbles can be noticed as in Fig. 5. *A*, represents the enamel; *B*, represents the ground coat.

Lepidolite varies in color, from a light pink to a dirty flesh color, especially if used in enamels containing tin or sodium antimonate.

There is little advantage, if any, in the use of lepidolite in either cast-iron ground coats or enamels.

Part II

A Ground Coat

The United States patent describes an enameling composition intended to be used as a cold ground coat. The composition is given as follows:

[4] Shively in an article entitled "The Principles of Glass Making," *Ceramist*, p. 238 (1924), gives the following information with regard to lithium oxide: "Lithium oxide is used only in the form of lepidolite which contains about 4% of the oxide. It aids in reducing the coefficient of expansion and is a strong flux, one pound of it being equivalent to over two pounds of sodium oxide."

	Parts
Silica	52–67
Clay and lime	14–17
Sodium	24
Boric acid	12
Broken glass and porcelains	40–60

The mixture is ground with water in a ball mill and used in the usual manner.

Earlier Works Raw and white ground coats were used successfully in Germany thirty years ago. The following raw ground coat formulas represent some which have been proposed.

Broken glass	46.00	60.00	40.00							20.0
Broken porcelain			16.00							
Silica	15.00	18.00	16.00		15.00	22.00	20.00	40.0	43.0	43.0
Fluorspar	2.00	2.00	2.00			2.00	2.00			
Feldspar	12.00	10.00	12.00			45.00	50.00			
Sodium nitrate	2.25		3.00	0.92	2.00		2.00			
Red lead			3.00		4.00					2.0
Clay	8.00	10.00	7.00	8.00	10.00	10.00	10.00	11.5	11.5	11.5
Colemanite	14.00				14.00	20.00	15.00	25.0	20.0	10.0
Cobalt oxide	0.25		0.25	0.37		0.25	0.25	0.5	0.5	0.5
Nickel oxide	0.50		0.50	0.46		0.50	0.50	1.0	1.0	1.0
Manganese dioxide			0.25			0.25	0.25			
Borolite*				56.00						
Borax				31.22				2.0	2.0	2.0
Sodium carbonate				2.76						
Aluminum				8.27						
Lepidolite										2.0

* Ph. Eyer, Jr. gives the following formula for borolite:

SiO_2	65.00	MgO	5.00
B_2O_3	8.00	ZnO	5.00
K_2O	5.00	Al_2O_3	2.00
CaO	10.00		
			100.00

	Fritted white ground coat				Raw white ground coat			
	1	2	3	4	1	2	3	4
Feldspar	52.00	48.00		30.00	20.00	10.00		
Silica	60.00	50.00	21.48	50.00	30.00	15.00		
Borax	72.00	66.00	24.05	64.00				
Pyrophyllite		14.00						
Sodium nitrate	4.00	6.00	4.28	5.00			2.00	
Fluorspar	4.00	6.00		3.00				
Litharge		3.00						
Antimony oxide	8.00	7.00			6.00	4.00	3.00	
Borolite			4.03					
Calcined clay			24.22		10.00	5.00		
Sodium carbonate			12.10	4.00				
Cryolite			9.84	2.00				
Meltoxyn*				14.00				
Opaque white glass					50.00	45.00	30.00	45.00
Colemanite					22.00	15.00	15.00	18.00
Clay					12.00	6.00	7.70	8.00
Cobalt oxide							0.15	
Nickel oxide							0.15	
Tin oxide								3.00
Broken porcelain							40.00	24.00

* Analyses made on meltoxyn gave the following results:

			Calculated mix
SiO_2	12.90	Kaolin	35.62
Al_2O_3	20.40	Calcium carbonate	6.62
CaO	4.60	Magnesium carbonate	2.61
MgO	1.71	Antimony oxide	55.26
Sb_2O_3	46.29		
Ignition loss	14.00		100.11

Mernagh[5] gives the following batch formulas:

	White gray ground coat	White ground coat		Mill addition
Antimony oxide	3.6	3.00	Clay	10.0
Borax	31.8	20.00	Magnesia	0.6
Calcium carbonate	1.7		Borax	1.0
White clay	2.2		Soda ash	0.3
Cryolite	7.2			
Feldspar	19.2	23.00		
Fluorspar	1.8	8.00		
Potassium nitrate	3.6			
Sand	23.3			
Soda	5.1	8.00		
Quartz		15.00		
Sodium nitrate		4.00		
Bone ash		10.00		
Boric acid		6.00		
Silica fluornatrium		4.00		

Part III

Essential Properties of Ground Coats

Adhesion is an essential property of ground coats. Different ground coat mixes were tried to prove that cobalt oxide is not the only effective component in the ground coat to obtain strong adhesion.

The application of the ground coat to the iron and its viscosity when fused are important. The viscosity of the ground coat is essential in order to resist the penetration of the gases from the casting. There are always bubbles in a good adhering ground coat.

FIG. 7.—Top view of the same glass eye, magnified.

The SiO_2, B_2O_3, and Na_2O are indispensable and these components must be in the ratio of 9 to 14 SiO_2, $2B_2O_3$, and Na_2O, regardless of all the other components present.

Cobalt manganese and nickel increase the viscosity of the ground coats but are not essential. Al_2O_3, CaO, PbO, MgO, and F should be used as little as possible. Sb_2O_3 and SnO_2 should be omitted entirely.

[5] Enamels, Their Manufacture and Application to Iron and Steel, p. 150.

To obtain data on the comparative adhesion of fritted and raw ground coats, tests were made as shown in the illustrations.

The adhesion of the ground coats was tested by subjecting them to impacts as described by C. J. Kinzie.[6] The number of blows resisted is marked on each figure.

Figures 3 and 4 are samples slushed with the writer's regular ground coat containing cobalt and nickel. The sample in Fig. 3 was broken from a lavatory and Fig. 4 is a sample taken from the rim of a flat rim tub. Where the ground coat was firmly adhered to the iron, the ground coat contained 15% or more of glossy bubbles. Where the ground coat possessed poor adherence it was smooth in appearance, or else the bubbles resembled dull slag-like burned masses. These results corroborate the work of Vielhaber reported in Die Zusammensetzung der Emailleglasuren.

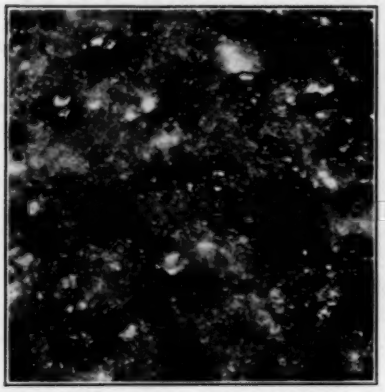

FIG. 8.—Represents a good fritted ground coat, containing cobalt and nickel. Magnified 40×.

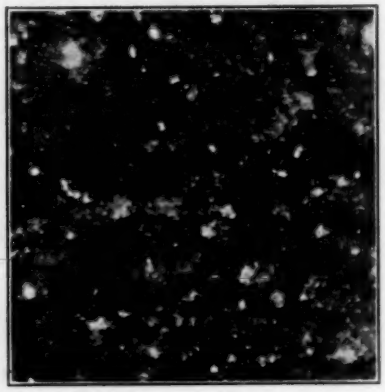

FIG. 9.—Represents also a very good fritted ground coat; contains no cobalt or nickel. Magnified 40×. Both Figs. 8 and 9 have a good adhesion quality.

A dark glass eye, created by the reducing gases from the metal is shown in Fig. 7. The distinct dark line of the ground coat and its good adhesion is clearly shown.

Figures 8 and 9 show two fritted ground coats applied on casting and fired without enameling. In Fig. 8 the ground coat contains cobalt and nickel; in Fig. 9 the ground coat contains no cobalt or nickel. The bubbles as seen are the same under the microscope, both ground coats possessing good adhesion to the metals.

WASHINGTON IRON WORKS
LOS ANGELES, CALIF.

[6] C. J. Kinzie, *Jour. Amer. Ceram. Soc.*, **12** [3], 188–92 (1929).

A SIMPLIFIED PRACTICE OF MIXING COLORED GLAZES[1]

By V. J. Roehm

ABSTRACT

A simple method of mixing colored glazes is discussed, using one base glaze, by means of curves plotted from predetermined values for the percentage of solids and ounces per pint in both base glaze and colored stains.

Introduction

At one of the plants where the writer is employed, four colored glazes and one transparent glaze are being produced. When this plant was built about thirty years ago, the possibility of running this many different glazes was inconceivable. Consequently, when the trade clamored for colored ware, the plant was handicapped by lack of grinding equipment,

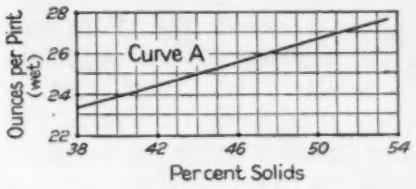

Fig. 1.

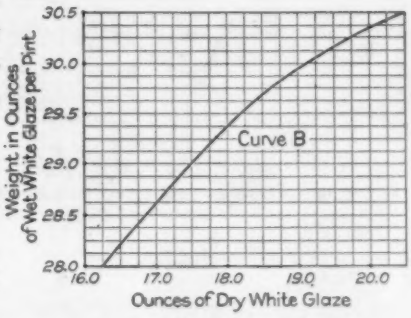

Fig. 2.

storage for new colored glazes, and also for space in the glaze department. By the method described below, the only equipment necessary was one grinding mill and a 50-gallon barrel with agitator for each of the colored stains used.

Procedure

One base glaze is used to which the different colorants are added. The stains are made up of the prepared color or calcines and ground very thoroughly in a ball mill with a certain percentage of the base glaze. The percentage of the coloring medium used is high to minimize the amount of stain to be ground and also the tank space required for the stain. After grinding, the stains are placed in wooden barrels of about 50-gallon capacity and kept in constant agitation. The colored glazes for dipping are prepared by pouring a certain number of pints of the stain into the dipping tubs, to which is then added the proper number of pints of base glaze.

To avoid drying out samples of glazes and stains each time, prior to mixing, a series of determinations were made and the data plotted, as shown in Figs. 1 and 2. In this way a great deal of time is saved. The chance for errors is more or less eliminated and regardless of the water

[1] Presented at the Annual Meeting, American Ceramic Society, Toronto, Ont., February, 1930 (White Wares Division). Received October 7, 1929.

content of the glaze or stain, the colored glaze can be made up without the necessary thinning or thickening to bring it to a certain gravity.

As an example, suppose a colored glaze is wanted whose composition is 95% base glaze and 5% of colorant. The glaze maker brings to the laboratory a pint of glaze stain and a pint of the base glaze. The base glaze is found to weigh 30 ounces to a pint and the stain weighs 26.7 ounces to the pint. A standard bucket is used holding 28 pints as the measure for the stain. The problem then is to determine how much base glaze of the above weight should be added to 28 pints (1 bucket) of the stain, which weighs 26.7 ounces per pint.

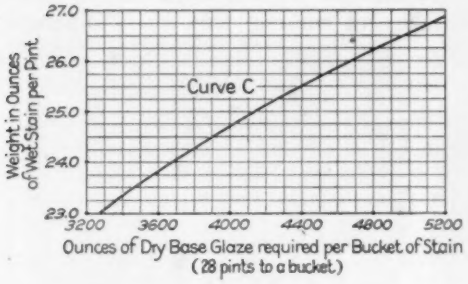

FIG. 3.

In Fig. 2 (curve B) it is shown that the 30-ounce glaze contains 19.1 ounces of solids. On curve A (Fig. 1), the stain weighing 26.7 ounces to the pint contains 50% solids or 13.35 ounces of solids. The glaze stain is made up of 80% colorant and 20% base glaze on the dry basis; therefore, a pint of the above stain contains 10.68 ounces of colorant and 2.67 ounces of base glaze. Twenty-eight pints of the above stain will therefore contain 299 ounces of dry colorant and 74.76 ounces of base glaze. Since the glaze is to contain 5% colorant and 95% base glaze on the dry basis, 299 is equal to 5% or 1% equals approximately 60 ounces. Therefore, the composition should contain 60 × 95 or 5700 ounces of base glaze. Seventy-five ounces of base glaze, however, is with the stain, so the amount of base glaze to be added is 5700 minus 75, or 5625 ounces of base glaze. Since the base glaze weighs 30 ounces to a pint and stains 19.1 ounces of solids, the number of pints of 30-ounce base glaze to be added is 5625 divided by 19.1, or approximately 294 pints. And since a 28-pint bucket is used for measuring, the final amount of white base glaze to be added is 294 divided by 28 which gives 10 buckets plus 4 pints.

Conclusion

If much work of this nature is done, a curve like that shown in Fig. 3 is convenient.

The writer does not know whether a method of handling a number of glazes in this manner has been done previously, but it is certain that with limited facilities, it is about as simple a practice as could be followed.

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[1] The abbreviation (*C. A.*) at the end of an abstract indicates that it was obtained from *Chemical Abstracts* by coöperative agreement.

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Abrasives

Designs double-disk grinder. ANON. *Abrasive Ind.*, **11** [2], 68 (1930).—The machine was designed by the Cleveland Armature Works, for the purpose of grinding flat, parallel surfaces, such as the end of bushings, coil springs, piston pins, piston rings, ball, roller-bearing races, etc. It is fitted with abrasive disks 20 in. in diameter. For the softer materials a cloth-backed $^1/_2$-in. thick abrasive is cemented to the disk; for harder materials a molded 1- or 2-in. thick abrasive is used secured to the disk by having the entire abrasive molded integral with the disk in circular dovetail slots. (Illustrated.) E.P.R.

Heavy-duty grinder. ANON. *Abrasive Ind.*, **11** [2], 69 (1930).—During the past few years there has been an insistent demand for grinding machines of various types to carry large wheels to effect greater production. A heavy-duty floor grinder recently designed by the Ransom Mfg. Co. for the Ford Motor Co. is illustrated. This machine carries two wheels 36 in. in diameter, has a 3-in. face, and is operated at a peripheral travel of 9500 ft. per min. E.P.R.

Rugged machines assist high rate of operation. ANON. *Abrasive Ind.*, **11** [2], 41–42 (1930).—A heavy-duty floor grinder capable of operating wheels 24 or 30 in. in diameter at a surface speed of 9000 ft. per min. was announced by the Norton Co. A comparatively small-size, high-speed floor grinder was developed by the Kling Bros. Engineering Works. This machine is designed in both floor and bench types. It carries 18-in. diameter wheels, operating them at a surface speed of 9000 ft. per min. A heavy-duty, floor-type machine to replace grindstones was developed by Luke & Spencer, Manchester, England. The wheel is located between two ball bearings, while the drive is by a tight and loose pulley from an overhead shaft. An electric grinder with the motor mounted between the two wheels was announced by the Production Equipment Co. The motor is of the squirrel-cage type, while the spindle operates in ball bearings. The Standard Electric Tool Co. brought out a combination grinder carrying

a regular wheel on one end of the spindle, while a ring wheel and swing table is mounted on the other end of the machine. The unit is electrically driven and the spindle operates in ball bearings. A heavy-duty floor grinder in 5-, $7^1/_2$-, and 10-H.P. sizes was brought out by the Hammond Machinery Builders, Inc. This machine is electrically driven with the motor mounted between the wheels. The motor is supplied with an air cleaner while the spindle runs in four ball bearings. A heavy-duty floor grinder which is a multispeed unit driven by a 10-H.P. motor was announced by the Hisey-Wolf Machine Co. The motor is mounted in the base while the drive is through V-belts. For off-hand grinding operations, the U. S. Electrical Tool Co. developed a novel heavy-duty grinder. This machine has a V-type disk transmission which consists of a series of meshing disks on the motor shaft and spindle. Improvements in its portable type grinder, a machine often referred to as a swing-frame grinder, were made by the Safety Grinding Wheel & Machine Co. An interesting floor grinder with automatic means for increasing the peripheral travel of the wheel as it wears away was developed by the Marschke Mfg. Co. grinder division of the Black & Decker Mfg. Co. When the operator sets the work rest, which is necessary as the wheel wears away, the movement of the rest actuates the mechanism for increasing the motor speed. A new type of direct motor-driven, high-speed swing-frame grinder was announced by the Sterling Grinding Wheel Co. In the design of this machine, high production with a minimum of physical effort were the chief objectives. E.P.R.

Disk and production grinder. ANON. *Abrasive Ind.*, **11** [2], 69 (1930).—A combination disk and production grinder recently announced by the Hammond Machinery Builders, Inc., is illustrated. The machine is made in four sizes. E.P.R.

Fast belt grinders cut excess metal. ANON. *Abrasive Ind.*, **11** [2], 44–45 (1930).—Many interesting machines have been developed to expedite sanding operations and these machines can be used for finishing a great variety of nonmetallic substances as well as wood. During the past year the Porter-Cable Machine Co. developed a number of sanding appliances, among the most important of which is a portable belt sander. The belt sander is used for finishing either wood or metal surfaces and consists of two rolls over which an endless abrasive belt is stretched. A novel form of portable belt sander was brought out by the Reid-Way Co. This machine has only one moving part, the sanding drum over which the abrasive material is stretched. The motor armature is stationary while the drum revolves. E.P.R.

Specialized disk grinding. ANON. *Abrasive Ind.*, **11** [2], 40–41 (1930).—A number of interesting developments were made in disk-grinding equipment during the past year, the trend being toward the improvement of automatic and semi-automatic units. An improvement made by Charles H. Besley is the development of a massive double-wheel machine for handling such work as piston rings, steel washers, starter-gear rings, etc. Another Besley development is a 42-in. vertical-spindle, wet-disk grinder arranged with a spring-geared feed lever table which permits the operator to grind work to size and also to use mechanical means to bring the work against the grinding member. E.P.R.

Standard grinding wheels reduce inventories and benefit users. ANON. *Abrasive Ind.*, **11** [2], 60–61 (1930).—The outstanding results due to the simplification of grinding wheels are (1) reduction in inventory, (2) less capital tied up in idle stock, (3) release of storeroom space, (4) increased turnover, and (5) prompt deliveries. J. F. McNeil discusses the findings of a survey recently conducted among the acceptors of the Simplified Practice Recommendation to determine the value of the program, in the January issue of the *Commercial Standards Monthly*. E.P.R.

Improved wheels more efficient. ANON. *Abrasive Ind.*, **11** [2], 47 (1930).—No grinding machine is better than the wheel with which it is equipped and this factor

has led grinding wheel makers during the past year to pay special attention to improving and refining their products with the object of meeting the exacting demands of production engineers. Some of the latest developments are briefly described. E.P.R.

Influence of grinding upon hardness of tools. ANON. *Mech. World*, **87** [2244], 6 (1930).—The life of a cutting tool depends upon the care taken in sharpening the edge. In order to ascertain the maximum thickness of layer that may be removed in grinding and the speed of operation, specimens were prepared and the surface was tested for Brinell hardness before and after the removal of the layer. The cuts were taken in two directions at a speed of 3.5 m. (11.5 ft.) per min., and the depth of cut ranged from 0.01 mm. (0.004 in.) to 0.52 mm. (0.02 in.). With a single exception it was found that the diminution in hardness increases with the depth of cut and the speed. E.P.R.

Special tools for grinding problems. ANON. *Abrasive Ind.*, **11** [2], 39–40 (1930).—Special grinding equipment points to the trend to employ abrasive processes to take the place of the slower production methods and inadequate tools. A brake-drum grinder which embodies a number of unusual features was developed by the Cincinnati Grinders, Inc. A special planetary grinder for finishing locomotive crankpins without removing them from the wheels was brought out by the Micro Machine Co. A novel machine for lapping gears was designed by the Lehman Machine Co. The functions of this machine are based on correct abrasion governed by the restraining movements of disks under pressure contact. A special grinding machine for finishing long tubing such as used in oil-well pumps was announced by the Hutto Engineering Co. The machine in question was designed for finishing tubing $3^1/_2$ in. in diameter and 20 ft. long. E.P.R.

Grinding tungsten-carbide tools. ANON. *Abrasive Ind.*, **11** [2], 54–58 (1930).—Carboloy is a trade name adopted by the Carboloy Co., Inc., New York, as a designation for tungsten-carbide tools. The article is reprinted from *Carboloy*. The cost of carboloy tools is exceptionally low considering such factors as metal removal between grinds and reduction of production costs. Due to the cost per gram of a carboloy tip, great precaution should be taken to prevent waste in grinding. A tool should not be crowded against a wheel at any time, whether rough or finish grinding is being done. Light pressure will enable an effective cutting action to take place without glazing or loading of the wheel, and without undue waste either to the tool or the wheel. Carboloy can be ground either dry or wet, with equal results. Cooling may be accomplished by submerging the shank until the tool cools sufficiently to continue. Because slight heating usually results on the larger sizes of tools several tools should be handled at one time, so that no lost time exists in waiting for a tool to cool. When wet grinding is done, it should be absolutely wet, and not just partially wet. Keep an adequate flood of coolant on the tool at all times while grinding. If grinding is started dry and then followed with a dash of water there is a likelihood of checking the carboloy tip. Occasional dressing of the wheel, either with a mechanical dresser or diamond, is highly advantageous because a loaded or glazed wheel only seems to retard metal removal and likewise creates excessive heat. A representative group of carboloy tools is illustrated showing the various forms of grinding most usually encountered, and some representative grinding operations performed on a variety of carboloy tools are shown. Various types of form tools can be ground in a surface grinding machine by dressing the wheel to the proper form, and dividing the operation into a roughing and a finishing grind. The form grinding of a tipped tool having a 0.25-in. radius at the cutting edge is illustrated. When a carboloy tool is finish ground by an abrasive wheel (60- to 120-grain) the cutting edge appears to be sharp and smooth, but stoning or honing the edge improves the sharpness of the cutting edge. Diamond-lapped tools are used extensively in the finishing of nonferrous metals, bakelite, hard rubber, fiber, babbitt,

and bronze. The diamond lapping of a carboloy-tipped tool is illustrated. The operation is performed after finish grinding has been completed, so that very little material is to be removed. The machine is of the horizontal type, having a revolving lapping plate directly driven by an electrical motor. For the average type of tools requiring lapping, an allowance of approximately 0.002 to 0.003 in. should be allowed. If the cutting edge is to be hand-lapped, in addition to being machine-lapped, there should be an allowance made of approximately 0.005 in. on a side. The lapping plates used are charged with diamond dust and are coated with a paste of diamond dust and olive oil on the lapping surface. This combination affords quick cutting and likewise produces an exceptionally smooth finish. E.P.R.

Sharp cutters basic requirement of high output. ANON. *Abrasive Ind.*, **11** [2], 38–39 (1930).—A number of improvements to tool-grinding equipment of various kinds was made during 1929. The Cincinnati Milling Machine Co. has developed a new cutter grinder. The new machine is a self-contained motor-driven unit and is made in two models, plain and universal. Improvements on its universal tool and cutter grinder were made by Alfred Herbert, Ltd., England. This machine resembles a universal cylindrical grinder and can be arranged to take care of various cutter-sharpening operations. An all-purpose tool grinder was brought out by J. G. Blount Co. This machine is fitted with three wheels, a 10-in. wheel for general use, a fine wheel of the same size for sharpening chisels, plane irons, etc., and a grinding cone for grinding gages, curved tools, etc. E.P.R.

Hair-line accuracy demands surface grinding. ANON. *Abrasive Ind.*, **11** [2], 36–37 (1930).—Improvements in surface grinding machines made during the past year point to the fact that this type of equipment is recognized as highly efficient. A continuous surface grinding machine was further developed by the Diamond Machine Co. This machine is fitted with rotating work-holding chucks which in turn are mounted on a revolving fixture so that the parts held on the chucks are carried past the grinding wheel face. Among the uses of this type of grinder are the finishing of ball-bearing lapping disks, chuck plates, motor bases, flat iron bases, etc., where quantity production and flat surfaces are essential. A special grinding fixture for use on its universal tool and cutter grinder for refinishing the work-support blades used in centerless grinders was designed by the Cincinnati Milling Machine Co. These blades should be ground frequently to remove the hollow resulting from wear. Ease of control is one of the leading features of a surface grinding machine improved by the Abrasive Machine Tool Co. This machine is of the type embodying a disk wheel mounted on a horizontal spindle and reciprocating table. The work can be strapped directly to the table or it can be held on a magnetic chuck. Full electric controls have been applied to a heavy-duty roll grinder improved by the Farrel-Birmingham Co. This grinder was designed for finishing accurately such work as large rolls used in steel mills, and is made in four sizes of 26, 32, 44, and 60 in., each machine having a maximum capacity for rolls of these diameters. E.P.R.

Sets fast pace to minute gage. ANON., *Abrasive Ind.*, **11** [2], 37–38 (1930).—Recent improvements made in internal grinding machines have been along the lines of refining existing models to take care of intensive production and the further development of large grinders of the planetary type. An internal grinder of the upright planetary type was improved during the past year by Beyer, Peacock & Co., Ltd., Manchester, England. This machine carries a grinding head in a slide fitted to the upright part of the base while the spindle operates in ball bearings and a taper adjustable bronze bearing. Semi-automatic features and refinement of design to take care of intensive production grinding were outstanding developments made by the Bryant Chucking Grinder Co. in its internal grinders. These machines work on a principle which embodies

a rotating work head with the grinding wheel head carried on an overhead arm. An internal grinding machine developed during the past year involves a new principle wherein the wheel enters the work from the back. This machine is a product of the Greenfield Tap & Die Corp. E.P.R.

Cushion change of direction by hydraulic drive. ANON. *Abrasive Ind.*, **11** [2], 33–36 (1930).—Cylindrical grinding machine development during 1929 points to the increasing use of semi-automatic machines and hydraulic power, the further development of multiple wheel machines, the motorizing of grinding equipment, and the increased use of large diameter wheels. The development of a 5 by 40 in. semi-automatic hydraulic cam grinder was an outstanding improvement made by the Landis Tool Co. during 1929. Salient features of this machine include frequent application of hydraulic power, end wheel-spindle drive through multiple V-belts, an improved underslung type attachment, automatic slow-down control for the work-drive motor, and other refinements. Due to its quietness, smoothness, ease of control, and flexibility, hydraulic power has been applied freely to Landis grinding machines. Several developments along the lines of special equipment for particular jobs were made by the Brown & Sharpe Mfg. Co., but no marked changes were made in the design of its standard machines. An important development in cylindrical grinders of the center type made by the Cincinnati Grinders, Inc., during 1929 was the introduction of a heavy-duty grinder fitted with a duplex table and a ball-bearing spindle and having increased power capacity. A semi-automatic plunge-cut grinder which embodies in its design a special adaptation of the units usually employed in center grinding was also developed by the Cincinnati Grinders, Inc. Four machines with hydraulic controls and a new crankshaft lapping machine were introduced by the Norton Co. during 1929. E.P.R.

Finish small parts economically. ANON. *Abrasive Ind.*, **11** [2], 80 (1930).—A large number of small parts must be polished and in cases where the finish need not be of the highest quality, burnishing in tumbling barrels with steel balls can be used. A full barrel will operate satisfactorily with a less number of balls in proportion to the work than if it were only half full. The correct size of balls used for a given operation can be determined by placing a ball in the sharpest corner or crevice of the work. Burnishing balls need not be perfectly round and if flat spots are in evidence this is no objection. Accuracy as to dimensions is of no consequence. Another economical and satisfactory method of polishing small parts consists of tumbling in sandstone and water in special tumbling mills. The abrasive medium in this instance is small pieces of sandstone which are procured very cheaply. These are broken up in little pieces approximately 1 in. square, the operator breaking up the pieces while the mills are in operation. Each mill is loaded with several hundred pounds of small cast-iron metal pieces and stone, and the barrel is nearly filled with water. It is allowed to operate for several hours. E.P.R.

Grinding compound. ANON. *Abrasive Ind.*, **11** [2], 71 (1930).—The use of sal soda and water as a grinding lubricant has been largely replaced during the past few years by various compounds which were developed to promote a good finish on the work, at the same time keeping the wheel free from chips. A late development along this line is a grinding lubricant recently announced by D. A. Stewart & Co. The new material is the result of practical experimentation and said to be the scientific adaptation of a new material heretofore not used for this purpose. E.P.R.

Use of diamonds. ANON. *Abrasive Ind.*, **11** [2], 70 (1930).—The nib in which a wheel-truing diamond is mounted can be turned in its holder to present a new cutting surface after the stone is worn flat. In grinding accurate work it is necessary to keep the wheel true. The diamond should be fed past the wheel at a uniform rate of speed which should be slow enough to give the diamond a chance to cut away the worn abra-

sive grain. To true the wheel for rapid cutting, the feed of the diamond should be increased. This roughens the face of the wheel somewhat, which permits it to cut free. Light cuts should be taken and plenty of lubricant used when truing a wheel with a diamond. Heavy cuts may dislodge the stone, while the absence of water heats the diamond. E.P.R.

Saw sharpener is automatic. ANON. *Abrasive Ind.*, **11** [2], 70 (1930).—Samuel C. Rogers & Co. has developed a full-automatic circular cross-cut and rip saw sharpener. This machine is of simple construction. It embodies five new features among which are a ball-bearing grinding wheel spindle and metal cabinet, enclosing all working parts. E.P.R.

Lathe has independent spindles. ANON. *Abrasive Ind.*, **11** [2], 69 (1930).—A double-spindle polishing lathe was developed recently by the Gardner Machine Co. To obtain independent operation of the two spindle ends, two single-end spindles are used, each carrying a multiple-groove sheave. A motor having a double-shaft extension is mounted on a sliding bracket at the rear of the base and carries a sheave on each end of its shaft. (Illustrated.) E.P.R.

Special abrasive machines eliminate manual labor. ANON. *Abrasive Ind.*, **11** [2], 76–78 (1930).—A number of outstanding special abrasive machines together with their manufacture are briefly described. E.P.R.

Polishing industry standardized on engineering basis. HENRY R. POWER. *Abrasive Ind.*, **11** [2], 72–74 (1930).—P. points out that polishing now is more or less an art wherein the human element predominates and that production polishing should become standardized and, like production grinding, become listed among the engineering sciences. E.P.R.

Buffing and polishing compositions. ANON. *Brass World*, **26** [1], 18 (1930).—A complete line of polishing and buffing compositions for all purposes is offered by The Buckeye Products Co. The Company's *Bulletin* No. 1, Vol. V, lists a number of compositions under the trade name "Speedie," which are designed for use on several specific varieties of work. E.P.R.

Automatic polishing methods. ANON. *Abrasive Ind.*, **11** [2], 43–44 (1930).—Considerable attention was given to the development of polishing-room equipment during 1929. The Hammond Machinery Builders, Inc., brought out an electrically-driven polishing and buffing lathe used primarily for finishing automobile fenders, although the lathe can be used also on a wide range of other work. A polishing and buffing lathe with a motor enclosed in the base, drive to the spindle being through a multiple V-belt was developed by the Hisey-Wolf Machine Co. This machine has an overhanding spindle. The Gardner Machine Co. developed a single-spindle polishing lathe which embodies a number of advantages such as any desired spindle speed with alternating current drive, the use of V-type multiple belts, and compactness and convenience of operation. A polishing and buffing lathe with a geared drive between the motor shaft and the spindle ends was designed by the Mitchell Engineering Works. A double-spindle motor polishing lathe made in 3-, 5-, and $7^1/_2$-H.P. sizes was developed by the Standard Electrical Tool Co. Any speed from 2000 to 3000 r.p.m. can be obtained by changing pulleys. The Excelsior Tool & Machine Co. brought out a 4-station polishing machine fitted with a circular revolving work-table for the rough grinding, polishing, and buffing of flat and semiflat articles such as castings, forgings, stampings, sheet metal parts, etc. A continuous feed-strip polishing machine was improved by Luke & Spencer, Manchester, England. This machine consists of a base on which any number of polishing units are placed so that the machine can be a 2-, 3-, 4-, or other multiple unit. The polishing medium consists of abrasive coated belts which operate over pulleys while the strip stock is fed through by rollers. E.P.R.

Solingen grinding industry is centuries old. ANON. *Abrasive Ind.*, **11** [2], 58–60 (1930).—It is pointed out that the grinding industry in the Solingen district is over 600 years old, at which time the sword industry was making considerable progress. The inhabitants of the Solingen district have followed the grinding trades for generations, which accounts for the high degree of manual skill for which these workmen are noted. E.P.R.

Grinding data. ANON. *Abrasive Ind.*, **11** [2], 47 (1930).—A new booklet, Precision Grinding Applications, has been issued by the Cincinnati Grinders, Inc. Approximately 40 grinding machine installations are shown on a wide variety of work. Both center-type and centerless grinders are illustrated with a brief description of each. E.P.R.

PATENTS

Automatic grinding machine. AMOS P. STEINER. U. S. 1,744,587, Jan. 21, 1930. A grinding machine comprising an abrading device, a headstock, a tailstock, a worktable, a pivoted bracket thereon carrying the headstock and tailstock, workholding means on the headstock and tailstock, a magazine, means for oscillating the bracket to feed the workholding means toward and from the abrading means, means for bringing the workholding means and the abrading device into and out of operative relations, means for replenishing the work while the devices are out of operative relation including a fluid motor on the bracket, a valve controlling the entry of pressure fluid, a fixed abutment for moving the valve during the oscillation of the bracket to admit fluid to the motor, a camshaft on the carriage, cams on the camshaft for oscillating the bracket, and a motor on the carriage for driving the camshaft.

Grinding machine. HARRY L. HOOD. U. S. 1,744,766, Jan. 28, 1930. A machine of the character described having, in combination, a grinding wheel, a work holder mounted for oscillation across the peripheral face of the grinding wheel, and means comprising an eccentric and eccentric strap connected to the work holder for producing relative movement between the work holder and the grinding wheel in a direction to cause the work holder to approach or to recede from the grinding wheel.

Grinding and polishing apparatus. LOUIS SCHULTE. U. S. 1,744,807, Jan. 28, 1930. A grinding or polishing apparatus including a belt, a pair of pulleys around which the belt passes, one of the pulleys being formed of laminated flexible disks.

Machine for surfacing sheets. LOUIS SCHULTE. U. S. 1,744,808, Jan. 28, 1930. A machine for treating the surface of plates, etc., including a carriage, a clamping means on the carriage at one end only, a surface-treating element in the path of travel of the carriage-clamping means, means for reciprocating the carriage, a guideway along which the carriage travels, one end of the guideway having an incline therein whereby the clamping means at one end of the carriage may move under the surface treating element without contacting therewith and whereby the carriage and clamping means will be raised upon further movement thereof in one direction to bring a plate on the carriage into contact with the surface-treating element.

Lapping machine. WILLIAM F. GROENE. U. S. 1,744,886, Jan. 28, 1930. In a lapping machine, the combination of means for rotating a crank shaft, lapping members arranged in pairs to engage over and move with the surfaces of the crank shaft to be lapped, under power applied thereto by the shaft, and power-operated means for applying and removing the lapping members from the surfaces to be lapped after a predetermined number of rotations of the crank shaft.

Cylinder grinder. JOHN JOHNSON. U. S. 1,745,015, Jan. 28, 1930. A device of the type described comprising a main shaft having an offset portion and a longitudinally extending groove disposed therein, a bar disposed in the groove and having one

end pivotally secured to the main shaft, the bar having a longitudinally-extending opening therethrough, a shaft extending through the opening, power means disposed upon the bar and operatively connected to one end of the shaft for rotating the shaft, a grinding wheel rigidly mounted upon the other end of the shaft adjacent and partially within the offset portion of the main shaft, the main shaft being adapted to be disposed within a cylinder of a motor block, a turntable having an opening arranged to receive the main shaft and the bar for holding the main shaft and the bar against rotation with respect thereto, a main frame arranged to rotatably receive the turntable, the main frame being adapted to be secured to the motor block at one end of the cylinder, an auxiliary frame arranged to be rigidly secured to the motor block adjacent the other end of the cylinder, the auxiliary frame being arranged to rotatably receive the main shaft, an adjusting screw extending through a threaded opening in the offset portion of the main shaft and arranged to engage with the bar adjacent the end opposite that of its pivot, a gear arranged to receive the adjusting screw, means for rotating the gear for moving the adjusting screw for moving the bar whereby the grinding wheel may be brought into engagement with the wall of the cylinder, and means operatively connected to the turntable for rotating the turntable, the main shaft and the bar for moving the grinding wheel in a circuitous path.

Wheel-grinding device. DANIEL C. MULVIHILL. U. S. 1,745,026, Jan. 28, 1930. In a wheel-grinding device, a frame means for supporting a car wheel and holding the same in upright position within the frame, means for rotating the wheel while on the first-named means, a hub-grinding element, a supporting member extending longitudinally of the frame in a plane transverse to the axis of the wheel hub when on the first-named means, and means for pivotally and slidably connecting the element to the member whereby when a wheel hub is being ground the element may be moved to and from the hub in a plane parallel with the axis of the hub and may be slid along the member in a plane transversely thereto, the center of gravity of the hub-grinding element being outwardly of the supporting member whereby the element will be normally held by gravity in inoperative position.

Abrasive sheet material. GUSTAVE E. BEHR, JR. U. S. 17,580, Feb. 4, 1930 (reissue). Method of making flexible abrasive sheet material consisting in combining with a suitable base, a waterproofing agent comprising cotton-seed oil impregnated into the fibers thereof, and a separately applied grit-holding coating of adhesive miscible with the cotton-seed oil and firmly bonded with the impregnated fibers.

Abrasive article. FRANCIS GURNEY OKIE. U. S. 17,593, Feb. 11, 1930 (reissue). The new article of manufacture in the nature of sandpaper comprising a flexible sheet of fabric, a grit or layer of abrasive particles, a waterproof stable penetrative adhesive bond interposed between the grit and the sheet, and a compensatory auxiliary bonding coat applied to the article, the bond and auxiliary coat being of a nature to maintain the bonding effect throughout the effective abrading life of the abrasive article when employed in a water abrading operation and not deleteriously affecting the flexibility of the sheet when dry.

Grinding apparatus. JOHAN RICHARD GUSTAFSSON. U. S. 1,748,343, Feb. 25, 1930. In a grinding apparatus for grinding crank pins and journals on locomotive and railway car wheels, the combination of a spindle having a plane end surface perpendicular to the axis of the spindle, a support for a grinding tool rotatable on the spindle, and means for clamping the spindle to such crank pin in axial alignment therewith and with the plane end surface of the spindle bearing against the plane end surface of the crank pin, the clamping means comprising an outer brace adapted to support the outer end of the spindle and having a rocking engagement therewith, a second brace adapted to be placed against the wheel, and stay bolts connecting the two braces.

Abrasive compound. ROBERT S. LEATHER. U. S. 1,748,778, Feb. 25, 1930. A solid abrasive preparation comprising a mixture of glue, water, abrasive, formalin, and glycerine, the preparation being readily transferable to a revolving buffing wheel by friction.

Grinding calender rolls, etc. H. R. WILLIAMS. Brit. 322,142, Jan. 15, 1930. In a machine for grinding long heavy rolls such as calender rolls, the roll is supported and rotated in a substantially upright position while a grinding wheel is traversed longitudinally along the roll, automatic means being provided to vary the distance between the grinding wheel and the roll axis so as to impart the required camber to the roll.

Trimming grinding wheels. GEAR GRINDING CO., LTD., AND J. W. SNARRY. Brit. 322,358, Jan. 22, 1930. Pantograph mechanism for trimming the operative faces of a shaped grinding wheel employed for grinding gears, splined shafts, etc., consists of a link attached to a fixed pivot, a subsidiary parallel link, a lever joining the upper ends of the links, and a lever joining the lower ends of the links and carrying a roller or projection which engages a pair of templets, one for each face of the wheel.

Abrasive compositions. C. J. BROCKBANK. Brit. 322,448, Jan. 29, 1930. In the manufacture of vitrified abrasive wheels, etc., a titanium compound, *e.g.*, the silicate, aluminate or dioxide, or titanium calcium silicate (titanite) is incorporated in the bond. *E.g.*, feldspar (70 parts by weight), china clay (25 parts) and titanium dioxide (5 parts) are formed into plastic balls, fired, and crushed to a fine powder and then mixed with the abrasive moistened with dextrine, etc., solution, in the proportion of 15 to 85. Wheels, etc., are molded from the composition, dried, and heated in an oven to the temperature of vitrification.

Abrasive compositions. C. J. BROCKBANK. Brit. 322,449, Jan. 29, 1930. Grinding wheels are made by mixing the abrasive with a solution in diethylene glycol monoethyl ether of rubber, shellac, or an artificial resin or a mixture of one or more of them, molding in the cold and baking.

Grinding pistons, etc. C. TALBOT, LTD., AND P. E. KNELL. Brit. 322,950, Feb. 5, 1930. Apparatus for grinding cylindrical surfaces, *e.g.*, that of a piston, consists of three grinding strips in grooves in a casing, the strips being movable radially by springs and pins operated by the conical interior of a sleeve which screws in a sleeve and is rotated to an extent limited by adjustable stops by a handle.

Art

Italian majolica. BERNARD RACKHAM. *Pottery Gaz.*, **55** [632], 292–99 (1930).—The name "majolica" is applied to pottery with metallic luster decoration, in the first instance to the Spanish lustered ware imported in quantity during the 15th Century in Majorcan vessels from Valencia into Italy. The term was later used for the similar lustered pottery made in Italy in emulation of the Spanish; subsequently its use was extended to all kinds of earthenware with painted decoration, whether in luster or in ordinary pigments over a ground of white tin enamel. The name "majolica" should strictly be confined to tin-enameled earthenware. Toward the end of the 15th Century the first beginnings of purely pictorial representations on majolica are found. The chief of several leading centers of the majolica industry was Faenza. So important was the position of Faenza as the leading ceramic center of the time that its name, "faience," was adopted in France. R. gives interesting history of European pottery.

E.J.V.

Antique vases. CHRISTINE ALEXANDER. *Bull. Met. Mus. Art*, **24** [8], 202–204 (1929).—Vases recently acquired include (1) a fragment of Etruscan red bucchero ware of the sort found in 7th Century tombs; (2) a cup of gray-brown ware such as is found in Palaeo-Etruscan tombs; (3) a number of oil jugs which may have been made by

the 7th Century potteries of Corinth (they are in the form of animals); (4) a faience aryballos in the form of a hedgehog, which has been assigned to the Greek colony of Naukratis in the Delta and was probably made in the early 6th Century B.C., is Greek in form although the material and glaze are Egyptian; (5) a little flask of delicate Hellenistic workmanship is in the form of two negro heads and has a black glaze; (6) a lekythos in form of a flying Eros holding a thymiaterion has long gilt curls, blue wreath, red fillet, blue and red garment, purple and gilt head-dress, and blue and gilt wings; (7) two Italic pieces have traces of brilliant color, one with black glaze and ornamented with winged figures in relief; the figures are treated with white slip, then painted *in tempora* in the manner of contemporary terra cotta figures; (8) a pyxis with no glaze but painted entirely in polychrome, has kept much of its brilliant color; (9) an Apulian skyphos has black glaze and is decorated with an ivy pattern and a bird painted in white on both sides. A.A.A.

Memorial exhibition. JOSEPH BRECK. *Bull. Met. Mus. Art*, **24** [11], 279–80 (1929).—In appreciation of the work of Adelaide Alsop Robineau, a memorial exhibition has been arranged by the Museum. In this exhibition there are some sixty to seventy examples of her porcelains which were loaned by S. E. Robineau, the Syracuse Museum of Fine Arts, and the Detroit Institute of Arts. Seven pieces owned by the Metropolitan and some examples from private collectors are included. See also *Bull. Amer. Ceram. Soc.*, **8** [5], 121–24 (1929). A.A.A.

Adelaide Alsop Robineau. ETHEL BRAND WISE. *Amer. Mag. Art*, **20** [12], 687–91 (1929).—History of Mrs. Robineau with description and illustrations of her work. See also *Ceram. Abs.*, **8** [6], 389 (1929). E.B.H.

Glass cutting. WOLFGANG GREISER. *Glashütte*, **59** [52], 951 (1929).—A general discussion of the art illustrated with photographs of cut glassware is presented. L.T.B.

Schlesien glass grinding. WOLFGANG GREISER. *Glashütte*, **59** [52], 951 (1929).—A discussion of some of the problems confronting the artisan of today is given. L.T.B.

Colored glass for interior decoration. ANON. *Glass Ind.*, **11** [2], 44 (1930); *Christian Sci. Mon.*, **22** [58], 3 (1930).—The possibility that the interiors of homes, public buildings, and theaters may soon be completely redecorated every day by merely touching a button was demonstrated before a meeting of the Illuminating Engineering Society. Christened Colorama, the application of the third dimension in color lighting to homes and public buildings makes possible thousands of color combinations and patterns upon walls painted plain white and devoid of all ornamentation. These colors and patterns remain stationary or continuously merge by means of a remote control board. This board is, in effect, a mechanical console upon which the color organist plays a symphony of light, controlling more than 7000 lamps of red, blue, green, and clear glass concealed in a series of coves and flutes in the walls and ceilings. Though only red, green, and blue are used, the mixing of these gives hundreds of shades of gray, orange, black and white, yellow, purple, and cerise, as well as many pastel shades. The color effects which can be obtained are unlimited in number. So far more than 1200 combinations and color effects have been produced. E.J.V.

"Selenium red" as ceramic color. J. H. POLGREAN. *Trans. Ceram. Soc.* [Eng.], **28** [2], 87–90 (1929); for abstract see *Ceram. Abs.*, **8** [2], 89 (1929). R.F.S.

New way of etching china. ANON. *Christian Sci. Mon.*, **22** [59], 7 (1930).—Instead of immersing the pieces of decorated china in diluted hydrochloric acid for several hours, which is the method commonly employed, the pure acid is applied directly to the china with a brush, a process requiring great care. The result is sharper contrast between the detail of the design and the plain surface from which the glaze has been eaten

away by the acid down to the bisque. The etched design is then finished in gold, silver, or platinum. (Illustrated.) E.J.V.

Tile decoration. J. W. THOMPSON. *Pottery Gaz.*, **55** [632], 261 (1930).—Experiments were made with a view to causing solutions of suitable coloring compounds to crystallize out on the surface of glazed tile. Crystallization is of two types, (1) from labile solutions, where crystallization is rapid, and (2) metastable solutions, where crystallization is slow and uniform. The essential differences between these two forms of crystallization is that inoculation is necessary in a metastable solution, whereas in a labile solution crystallization is spontaneous without inoculation. Solutions of copper, cobalt and ferrous sulphate, and other substances were made up and applied to the surface of glazed tile by means of an aerographing pen, the tile then being dried on a flat shelf. The tile were fired in an ordinary muffle glaze kiln and it was found that in most cases a medium heat was the best temperature for the majority of solutions tested. Trials were made in the hope of discovering the effects of zinc, magnesium, and aluminium sulphate additions, and with mixtures of simple solutions. The process is still in the experimental stage. E.J.V.

International exhibition of contemporary glass and rugs. C. LOUISE AVERY. *Bull. Met. Mus. Art*, **24** [10], 250–53; **24** [11], 288–94 (1929); for abstract see *Ceram. Abs.*, **9** [2], 82 (1930). A.A.A.

Better design. R. W. SYMONDS. *Spectator*, No. 5291, pp. 792–94 (1929).—The arts and crafts of the civilized world are said to be at a low ebb. The plea is made that designers should follow engineers and consider function only and not effect. H.H.S.

Craftsmanship of artists. FRANK RUTTER. *Spectator*, No. 5291, p. 796 (1929).—The laboratory work of the present generation is said to be pretty well concluded. In the next decade or two artists may perfect their craftmanship for the greater beauty and permanence of their productions. H.H.S.

Common brick in gardens. J. KASSMAN. *Brick Clay Rec.*, **76** [2], 113 (1930).—An illustrated description of the possibilities for beauty, usefulness, and variety in the use of common brick for walls, etc., in a garden. E.J.V.

Walled garden of stucco and tile. ANON. *Good Housekeeping*, **90** [3], 55 (1930).—A colored illustration showing an effective use of stucco for walls and vitrified tile for flooring and wall decoration is given. E.J.V.

Two black basalt figures of historical interest. RUTH RALSTON. *Bull. Met. Mus. Art*, **24** [9], 232–33 (1929).—Two small, beautifully modeled figures of Admirals Rodney and Hood have been loaned to the American Wing of the Museum. They are typical of the figures offered for sale in England and America in the second half of the 18th Century, and probably were produced to commemorate the victory of Rodney and Hood over DeGrasse in West Indian waters in 1782. They are made of the fine stoneware known as black basalt, perfected by Josiah Wedgwood and widely imitated by other potters. The pieces are signed by the modeler, Stephan, who was famous for his portraits of national heroes. The figures might have come from the Wedgwood potteries, but it is thought they were made by John Turner of Lane End, chief of Wedgwood's competitors. A.A.A.

Paleolithic clay art in Moravia. KARL ABSOLON. *Illus. London News*, **175**, 934–38 (1929).—In the Zabrovresky suburb of Brno, A. has discovered remains of mammoth hunters of the early Stone Age. Among the remarkable finds are statuettes made of clay paste and charred and powdered bones (including mammoth-bone). He attributes the art to accidental revelation by rain, and wonders that they did not go on to the construction of pots and pans which were not fashioned until thousands of years later. H.H.S.

Ceramics. LIDA MATULKA. *Design*, **31** [9], 175–78 (1930).—The earliest examples

of Czech ceramics are earthen vessels and tile with transparent lead glaze. Majolica was finer ceramics with an opaque coating of lead or pewter on a white surface, richly decorated, rare because of its technical perfection and bright rich coloring. The peasants offered their own interpretation of flowers or fruits as their characteristic decoration as in embroidery. The famous Haban ware was originated by a group of exiled Anabaptists from Germany who learned and improved the native technique. The name peasant ware distinguished that of cottage industry from Holic, produced in government factories for perpetuation and economic purposes. Illustrated. E.B.H.

Oil jars of Sicily. NOBLE FOSTER HOGGSON. *Art and Archaeology*, **28** [3], 89–94 (1929).—Description of large oil and wine jars of Sicily. Those of simple constructive lines are considered superior to those decorated in relief which minimizes the silhouette. E.B.H.

Potter of the past. ANON. *Pottery Gaz.*, **55** [632], 285 (1930).—A brief biographical sketch of the first Thomas Poole, the founder of the Cobden Works of the present business of Thomas Poole, Ltd., of Longton is given. Illustrated. E.J.V.

BOOKS

Dictionary of Marks and Monograms of Delft Pottery. JEAN JUSTICE. Herbert Jenkins, Ltd., London, 1929. Price 21s. 1400 different marks are illustrated and described. H.H.S.

Evolution of Art. RUTH DE ROCHEMONT. Macmillan Co., London, 1929. 600 pp. Price 25s. H.H.S.

PATENTS

Design for plate. URASABURO TOMITA. U. S. 80,458 to 80,469, Feb. 4, 1930, and U. S. 80,552 and 80,553, Feb. 18, 1930; CHARLES L. SEBRING. U. S. 80,497, 80,498, and 80,499, Feb. 11, 1930; LEWIS H. BOWN. U. S. 80,510, Feb. 18, 1930.

Design for tumbler. EDWIN B. ADAMS. U. S. 80,508, Feb. 18, 1930.

Design for goblet. GEORGE DOUGHERTY. U. S. 80,512, Feb. 18, 1930.

Design for bowl. EDDY FAIRCHILD. U. S. 80,513, Feb. 18, 1930.

Design for dish, etc. WILLIAM P. GRAHAM. U. S. 80,520, to 80,523, Feb. 18, 1930.

Design for vase. DONALD M. SMITH. U. S. 80,543, Feb. 18, 1930.

Design for flask. EDWIN WENDELL FUERST. U. S. 80,567, Feb. 25, 1930.

Ornamental glass. LOUIS GÖBEL. Ger. 484,072, July 9, 1926. Clear or opaque glass is coated with asphalt, sprayed with benzine so as to remove the coating in part, and then immersed in an etching bath. (*C. A.*)

Cement, Lime, and Plaster

Chemical, microscopic, and X-ray photographic examination of alite. A. GUTTMANN AND F. GILLE. *Zement*, **18**, 30 (1929); *Rock Prod.*, **32** [24], 190 (1929).—American investigators conceive alite to be a tricalcium silicate whereas German investigators consider it to be a mixed crystal or a mixture of various substances. This difference of opinion is due to the absence of a satisfactory analysis of the alite. Alite crystals were obtained, as pure as possible, from two clinkers of varying composition, analyzed chemically and microscopically, and photographed with X-rays. The results show tricalcium silicate to be the main constituent of alite, with celite, aluminate, and sometimes free lime as auxiliary constituents. There is a complete absence of bicalcium silicate, contrary to the conception of Jänecke (see *Ceram. Abs.*, **8** [12], 866 (1929)). A method is given for calculating whether the limit value of the lime in the Portland cement has been reached or exceeded. W.W.M.

Tricalcium silicate investigation. E. JÄNECKE. *Zement*, **18**, 46 (1929); *Rock Prod.*, **32** [26], 96–97 (1929).—J. shows that the X-rayogram of "tricalciumsilicate" as determined by Hansen and Brownmiller contains the diagrams of CaO and $2CaO \cdot SiO_2$. He states that Guttmann and Gille represented alite unintentionally as a mixed crystal of $2CaO \cdot SiO_2$ and $8CaO \cdot Al_2O_3 \cdot 2SiO_2$. They, in answer, certify by optical and chemical determinations the conformity of alite with tricalcium silicate. Conclusions of J. do not break down the findings of Guttmann and Gille. See abstract above.

W.W.M.

Structure of tricalcium silicate. E. JÄNECKE. *Zement*, **18**, 48 (1929); *Rock Prod.*, **33** [2], 82 (1930).—J. defines "tricalciumsilicate" as a mixture of CaO and $2CaO \cdot SiO_2$, and Guttmann and Gille insist it is a mixture of bicalcium silicate and free lime. J. contends that his X-ray pictures are not inaccurate and Guttmann and Gille present proof to the contrary. See review of book by H. Kühl, this issue *Ceram. Abs.*, p. 262. In addition, work on this subject has been published by W. C. Hansen, *et al.*, *Ceram. Abs.*, **6** [7], 305 (1927), *ibid.*, **6** [6], 239 (1927); Guttmann and Gille, *ibid.*, **7** [2], 68 (1928), *ibid.*, **7** [8], 513 (1928). W.W.M.

Best raw mix for cements. HANS KÜHL. *Zement*, **18**, 27 (1929); *Rock Prod.*, **32** [26], 97 (1929).—K. states that the best raw mix for cement is calculated by the formula:

$$X = -\frac{2.8SiO_2 + 1.1Al_2O_3 + 0.7(Fe_2O_3 + Mn_2O_3) - CaO}{2.8SiO_2 + 1.1Al_2O_3 + 0.7(Fe_2O_3 + Mn_2O_3) - CaO}$$

X = pounds of limestone to be mixed with one pound of clay. The analysis figures for clay are entered in the numerator and those for limestone in the denominator. Formulas proposed for the best lime contents are:

$CaO = 1.86SiO_2 + 2.2Al_2O_3 + 0.7Fe_2O_3 + 5$ (Jänecke)
$CaO = 2.8SiO_2 + 1.1Al_2O_3 + 0.7Fe_2O_3$ (Guttmann and Gille, also Kühl)
$CaO = 2.8SiO_2 + 1.65Al_2O_3 + 0.35Fe_2O_3$ (Guttmann and Gille)

W.W.M.

Quality formula for cement. NILSSON. *Zement*, **18**, 47 (1929); *Rock Prod.*, **33** [2], 82 (1930).—Kühl considered the formula, $CaO = 2.8\,SiO_2 + 1.1\,Al_2O_3 + 0.7\,Fe_2O_3$, as giving the best cement composition. N. introduces into this formula the hydraulic modulus H, the silica modulus S, and the iron modulus E, and arrives at the formula

$$H = \frac{2.8 \times S \times (E + 1) + 1.1 \times E + 0.7}{(S + 1) \times (E + 1)}$$

If two of the three moduli, H, S, and E are fixed the third can be calculated. Values of H for various S and E values are given in the table below. The E values may be

$E = 0$		$E = 1$		$E = 2$		$E = 3$		$E = 4$	
S	H	S	H	S	H	S	H	S	H
1	1.75	1	1.85	1	1.88	1	1.90	1	1.91
2	2.10	2	2.17	2	2.19	2	2.20	2	2.21
3	2.27	3	2.32	3	2.34	3	2.35	3	2.35
4	2.38	4	2.42	4	2.43	4	2.44	4	2.44
5	2.45	5	2.48	5	2.49	5	2.50	5	2.50
6	2.50	6	2.53	6	2.54	6	2.54	6	2.55

plotted as curves of the abscissa S and the ordinate H. To evaluate a given cement or clinker analysis, calculate the three moduli by formula or diagram and note how closely H approaches the ideal value. The quotient of the actual and ideal H gives the theoretical "quality factor." W.W.M.

Influence of magnesia, ferric oxide, and soda upon the temperature of liquid forma-

tion in certain Portland cement mixtures. W. C. HANSEN. Bur. Stand., *Jour. Research*, **4** [1], 55–72 (1930).—A study has been made of the influence of ferric oxide, magnesia, and soda upon the temperature at which melting starts when they are added individually and collectively to mixtures of lime, alumina, and cement. It was found that these mixtures with lime, alumina, and silica started to melt at 1455°C. When ferric oxide was added the temperature of liquid formation was reduced to 1340°C, with magnesia to 1375°C, with soda to 1430°C, with ferric oxide and magnesia to 1300°C, and with the three added components to 1280°C. The compounds observed at equilibrium in the clinkers made from lime, alumina, silica, ferric oxide, and magnesia were found by microscopic and X-ray methods to be $3CaO \cdot SiO_2$, $2CaO \cdot SiO_2$, $3CaO \cdot Al_2O_3$, $4CaO \cdot Al_2O_3 \cdot Fe_2O_3$, and MgO. R.A.H.

Tensile autogenous healing of Portland cement mixtures. HERBERT J. GILKEY. *Proc. A.S.T.M.*, **29** [II], 593–610 (1929); see *Ceram. Abs.*, **9** [1], 16 (1930). R.A.H.

Compression test for Portland cement. O. L. MOORE. *Proc. A.S.T.M.*, **29** [II], 570–92 (1929). R.A.H.

Rate of hydration of cement clinker. F. O. ANDEREGG AND D. S. HUBBELL. *Proc. A.S.T.M.*, **29** [II], 554–69 (1929). R.A.H.

Manufacture of Portland cement. C. G. CARTER. *Can. Chem. Met.*, **14** [1], 16 (1930).—An outline of the history and development of the manufacture of Portland cement from its discovery in 1827 by Aspdin up to the present era is presented. The two ratios which must be considered in the selection and mixing of the various ingredients used in the manufacture of cement are the ratio of the silica content to the sum of the alumina and iron contents, which should lie between 2:1 and 3:1, and the hydraulic modulus, or the ratio of the % lime to the sum of the % silica and % R_2O_3, which should be approximately 2:1. Detailed descriptions of the dry and wet processes of manufacture being used now are given. E.J.V

Setting and hardening of Portland cement in the presence of water-soluble admixtures. H. W. GONELL. *Z. angew. Chem.*, **42** [47], 1087–91 (1929).—The following experiments were undertaken to determine whether gel formation alone caused setting of cements or whether crystal formation contributed to it also. The nature of cement makes a direct study of this problem difficult so that certain water-soluble materials, which in small concentrations disturb setting, were added from which conclusions as to the normal processes were drawn. Normal hydration in cements results in the formation of needles of calcium hydrosilicate, hexagonal plates of $Ca(OH)_2$ and calcium hydro-aluminate and gel. In the presence of 0.1% sugar solution the formation of crystalline products of hydration was suppressed, while gel formation was greatly increased. In 10% sugar solution there were no crystalline products formed at all. Pats of cement made with sugar solution were still soft after several days. There is a slow hardening evident so that after one year the strength of cement made with sugar solution is about the same as that without sugar. This later hardening is due to the aging of the gel when it crystallizes as spherulitic growths. Thus both crystals and gel are necessary for normal setting. First the crystals cause the formation of a structure while the gel forms a filling and binding material in it. Without crystals there is attained no strength until the gel crystallizes at late periods. Other substances which suppressed crystal formation and increased gel formation were salts of heavy metals such as $PbNO_2$, $CuCl_2$, etc. Certain other salts increase crystal formation and hasten hardening. Na_2CO_3 is such a salt. If, however, too much of this salt is added (4%) there is no increase of strength on storage due to the suppression of the gels which cause such hardening. L.T.B.

Time of hardening of Portland cement. DANIEL AVDALIAN AND E. N. GAPON. *Giorn. chim. ind. applicata*, **11** [5], 203–206 (1929).—The process of the hardening of

Portland cement is divided into three phases: (*a*) hydration which lasts from two to three days, (*b*) diffusion (3 to 14 days), (*c*) crystallization. The authors analyze the process of hardening with relation to time only and do not touch on the chemical changes which take place. The following conclusions are given: (1) The velocity of the hardening of cement may be expressed in the following relationship: $\frac{1}{t}\log\frac{W_o - W_\infty}{W_t - W_\infty} = \text{const.}$ Where W_o is the value of the property of Portland cement in question (density, porosity, etc.) at the beginning of the process, W_∞, the same after hardening, and W_t, after the time, t. The value of the constant diminishes continually during the process which is explained with the increase in the thickness of the colloidal membrane. (2) Relatively for particular cases with a change in the quantity of water absorbed and the specific gravity, there are two formulas: $\frac{1}{t}\log\frac{P_\infty}{P_\infty - P_t} = C_1$, where $W_o = O$ and $W_\infty = P_\infty$ = water absorbed by porosity after hardening in time, t. $\frac{1}{t}\log\frac{d_o - d_\infty}{d_t - d_\infty} = C_2$, where $W_o = d_o$, density of the Portland cement at the beginning, $W_\infty = d_\infty$ = density of the hardened cement, $W_t = d_t$ density in the time, t. (3) The phases of the process of diffusion are characterized by the constant, $\frac{1}{\sqrt{t}}\log\frac{W_o - W_\infty}{W_t - W_\infty} = \text{const.}$ The constant of the process of hydration and the resistance to compression after 28 days are in direct relation to one another. This permits the deduction of the solidity of Portland cement from the constant of the velocity of reaction. M.V.K.

Action of magnesium hydrofluosilicate on Portland cement. ANON. *Zement*, **44**, 1302–1304 (1929); *Tonind.-Ztg.*, **53** [102–103], 1804 (1929). M.V.K.

Crystallization forces in cement. CURT PRUESSING. *Zement*, **18**, 41 (1929); *Rock Prod.*, **32** [26], 98 (1929)).—P. presents test data on the crystallization forces set up in the hardening of Portland cement. His data contradicts the contentions of Gensbaur (see *Ceram. Abs.*, **8** [7], 482 (1929)), that decrease in strength on so-called Kl storage is a dependable guide for measuring volume consistency. P. states that volume consistency is affected only by natural swelling and shrinking caused by the physical condition, and blowing caused by chemical nonequilibrium of the cement; while the phenomenon observed in Kl storage is a natural disturbance due to change of physical condition of the mortar specimens. The hardening process of cement is considered as a disintegration of the large molecular compounds of the clinker into the simpler compounds, approaching ultimately a simple lime salt, alumina silicate, and water-bearing silicic acid as the principal final products. This latter stage is not reached under natural storage conditions. The chemical condition of the specimens depends on their age and nature of storage. The reaction equilibrium between caustic lime and lime carbonate leans toward the former during storage in water and toward the latter during storage in air. A change in storage conditions, therefore, disturbs the state of equilibrium, leading to tensions in the specimen. This influences the strength of the cement if tested before the new equilibrium has been reached. According to the theory of Kl storage, fluctuations in strength should decrease as the specimens age. P. tested cements 9, 13, and 23 yrs. old and found the fluctuations equally extensive in specimens of any age and any mixing proportion. W.W.M.

Slag cements. SEVIERI. *Ind. del Cemento*, **26**, 4 (1929); *Rock Prod.*, **32** [26], 98 (1929).—S. reviews the nomenclature and history of artificial iron Portland cement, Portland-type blast-furnace cement, and the blast-furnace slag cement, referring to the literature of various countries. W.W.M.

Meaning of "special cement." FULD. *Zement*, **18**, 26 (1929); *Rock Prod.*, **32**

[26], 99 (1929).—E. discusses from a legal standpoint the definition of a special cement as applied to special Portland and natural cements. W.W.M.

Calcium sulphate and cement. ANON. *Ind. del Cemento*, **26**, 4 (1929); *Rock Prod.*, **32** [26], 98 (1929).—Addition of calcium sulphate and its various modifications to Portland cement is discussed, and test data as given by Budnikoff in *Stroitelnaja Promyschlennost*, **2**, 102 (1926) is presented. W.W.M.

Structure and chemical resistance of concrete. RICHARD GRÜN. *Z. angew. Chem.*, **42** [46], 1070–76 (1929).—(1) *Chemical constitution of cements.* There are three principal groups of cements differing mainly in composition: Portland, slag, and alumina cements. (2) *Chemical structure of concrete.* On hydrating, Portland cement forms monocalcium silicate hydrate, $Ca(OH)_2$ and tricalcium aluminate hydrate. The reactions of slag cements are similar but the $Ca(OH)_2$ recombines. On hydration of alumina cements there is formed tricalcium aluminate hydrate. (3) *Types of concrete.* There are 3 types of concrete: (*a*) concrete of the consistency of moist earth gives the greatest strength but is not very dense; (*b*) plastic concrete, used in reënforced structures because the former type cannot be placed readily into all the recesses of the reënforcement; and (*c*) wet concrete, containing an excess of water so that it flows easily. The structure greatly affects the resistance of concrete to attack. The nature of the solutions is also important. Salt solutions are by far the most harmful. Concrete may be protected from such solutions by a water-proof coating of the nature of a bituminous material. L.T.B.

Action of magnesium sulphate on cement. P. KREMSER. *Ind. del Cemento*, **26**, 8 (1929); *Rock Prod.*, **32** [26], 97 (1929).—K. describes the occurrence of magnesium sulphate and its chemical relation to cement. Lime is subject to the disintegrating action of magnesium sulphate according to the equation $Ca(OH)_2 + MgSO_4 = CaSO_4 + Mg(OH)_2$; the hydrate of magnesia being a white, copious gelatinous mass. The detrimental compound, sulpho-aluminate of calcium is then formed according to the equation: $3CaSO_4 + (3CaO \cdot Al_2O_3 \cdot 12H_2O) + 18H_2O = 3CaO \cdot Al_2O_3 \cdot 3CaSO_4 \cdot 30H_2O$. This action effects change of volume and disintegration of the cement. K. also describes results obtained by saturating the specimens with "Sika," a cement paint for reducing disintegration by magnesium sulphate. W.W.M.

Resistance, density, and proportion of water and cement in concrete and mortar. E. SWENSON. *Beton Eisen*, **28** [21], 397–402 (1929); *Tonind.-Ztg.*, **53** [102–103], 1804 (1929). M.V.K.

Sweating of concrete. ANON. *Concrete*, **35** [6], 16 (1929).—In a room containing warm, moist air, condensation will usually occur if the inner wall or floor surfaces are cooler than the surrounding air. This condensation can be prevented by (1) air changes, (2) proper temperature regulation, and (3) floor and wall insulation. E.A.H.

Admixtures in concrete. JOHN G. AHLERS. *Concrete*, **35** [6], 21–22 (1929).—Admixtures are usually claimed to improve the workability and quality of concrete, and technically this is accomplished by overcoming deficiency in the aggregates. A. states that admixtures do not compare with an equal money's worth of cement. E.A.H.

Admixtures. ROY CROSS. *Concrete*, **36** [1], 37–39 (1930).—Some opinions regarding value of admixtures in concrete are given. E.A.H.

Curing concrete. LEE S. TRAINOR. *Concrete*, **36** [1], 35 (1930).—The five requirements for a durable concrete are (1) durable impervious aggregates, (2) water-tight binding medium, (3) mixture that permits complete incorporation of the aggregates in the paste, (4) methods of mixing and placing to secure a uniform homogeneous mass, and (5) adequate protection and curing. Under favorable curing conditions, (1) a maximum amount of cement will be hydrated, (2) the concrete will be subjected to a

minimum amount of volume change during the period of low strength, and (3) bond strength, water tightness, resistance to abrasion, and other desirable properties of the concrete are materially improved. E.A.H.

New experiments with cement, cement mortar, and concrete. Otto Graf. *Z. Ver. deut. Ing.*, **73** [39], 1401–1404 (1929); *Tonind.-Ztg.*, **53** [102–103], 1804 (1929).—G. claims that standard specifications for cement tell very little about the behavior of cement when made into concrete, especially since the specifications are not rigid and practically all cements conform to them. In order to obtain good concrete other factors than the cement must be considered, such as the quality of the aggregate. Heretofore, quality of concrete has been measured by strength tests. Other tests might be substituted to judge quality: *e.g.*, bending strength. A series of experiments showed that bending strength is usually greatest when compressive strength is highest. L.T.B.

Determination of cement content of concrete. A. K. Light. *Can. Chem. Met.*, **14** [1], 16–17 (1930).—A 10-g. sample of 100-mesh concrete is moistened with hot water and treated with 100 cc. of 1:3 hydrochloric acid. After effervescence has ceased and the mixture has settled, the supernatant liquid is decanted, retaining the residue in the beaker, and washing with hot water twice by decantation; after 75 cc. of a 4% solution of sodium hydroxide is added, the mixture is heated to about 75°C or 80°C, stirring constantly. After heating for 10 to 15 minutes, the mixture is allowed to settle, then filtered and washed through the same Gooch crucible into which the acid solution was previously filtered, the entire residue being finally transferred to the crucible. After baking on the hot plate, the residue is moistened with hydrochloric acid, evaporated and again baked. Following taking up the residue wih 75 cc. of 1:4 hydrochloric acid and boiling until all soluble material is in solution, the material is filtered, washed well with both hot dilute hydrochloric acid and hot water, and finally ignited in platinum and weighed. The silica is liberated by treating with hydrofluoric acid and its weight determined by the weight lost during this treatment. This weight, divided by the average silica content of Portland cement, about 21.5%, gives the percentage of cement in the original concrete. E.J.V.

Effect of temperature on cement. A. C. Blackall. *Concrete*, **35** [3], 110 (1929).—Low temperatures tend to retard the setting and hardening of Portland cement to an extent that varies with the circumstances and with the cement. Before any inference is drawn regarding a particular cement it should be tested under conditions similar to those in which it is likely to be used in practice. E.A.H.

Chemical constitution of cements. Ferrari. *Ind. del Cemento*, **25**, 6 (1928); *Rock Prod.*, **32** [26], 98 (1929).—F. reviews the literature dealing with the chemical constitution of calcareous cements and cites references dating between 1785 and 1925. W.W.M.

Sugar in sand. N. H. Roy. *Proc. A.S.T.M.*, **29**, 611–17 (1929).—To determine sugar in sand bacteriologically a washing from the sand is placed in a test tube together with a small quantity of bouillon, the mixture is inoculated with Aerobacter aerogenes and set aside in a warm place for a short time. The presence of sugar is revealed by the liberation of carbon dioxide which is easily collected. The method is rapid and reliable and will detect minute quantities of sugar. Supporting data are included. R.A.H.

Cement resistance. Joseph Keith. *Tonind.-Ztg.*, **54** [2], 27–29 (1930).—The results of researches conducted by K. on (1) the changes in resistance of cements stored in water, and alternately in air and water, up to 365 days; and (2) the changes in resistance of cements with various combinations of storing for different periods of time, and their subsequent hardening under water are presented. Tables and diagrams give the results obtained with four kinds of cements. M.V.K.

Light-weight concrete as an insulating material. W. LUFT. *Z. Ver. deut. Ing.*, **73** [28], 998–1000 (1929).—This concrete is made by adding to the cement mortar a material which readily forms a foam and retains this form until after the cement has set. The concrete then contains innumerable pores and therefore makes an excellent insulating material. The compressive strength depends on the specific weight and composition. Moist curing does not increase the strength of the concrete. It is frost resistant and may be used in reënforced concrete without danger of rusting of the reënforcement. It is more resistant to fire than ordinary concrete and does not absorb great amounts of water. It makes an excellent sound insulator and has been used with success in various cities for insulating underground heating pipes. It has also been used in houses where sweating of walls is undesirable. L.T.B.

Protection of cement in chemical factories. ANON. *Rev. prod. chim.*, **15, 7** (1929); *Tonind.-Ztg.*, **53** [101], 1781 (1929).—Concrete used in the construction of chemical factories should be protected from the injurious action of chemicals and heat. This may be done effectively by the use of a bituminous coating. Natural bitumen is better than oil bitumen for this purpose and the commercial product containing resin or tar may be used only where sudden changes of temperature occur and where there is no contact with strong acids. As a thin coating of paint may be absorbed by the concrete, several coatings should be given, beginning with a ground coating which closes the pores. Asbestos may be added to the bituminous paint to render it more resistant to pressure and increase its elasticity. M.V.K.

Caustic magnesia for xilolite. ANON. *Tonind.-Ztg.*, **53** [99], 1740–42 (1929).—Caustic magnesia differs from other binding agents through its capacity to bind quantities of flux materials of organic nature. Standards for the supply and testing of caustic magnesia are outlined under the following headings: (1) *Chemical composition:* SiO_2 up to 15%, $R_2O_3 = Al_2O_3 + Fe_2O_3$ up to 8%, CaO up to 4.5%, MgO at least 75%, carbonic acid up to 6%, water up to 8%. (2) *Physical structure:* amorphous or crystalline. Weight of liter (poured) 850 g., (shaken) 1300 g., fineness 3% residue with 900-mesh sieve; fineness 15% residue with 2500-mesh sieve; fineness 25% residue with 4900-mesh sieve. (3) *Setting time:* commencement after 40 min., ending after 9 hrs. (4) *Change in volume:* shrinkage not more than 0.25%; extension not more than 0.15% of length. (5) *Solidity:* hardness determined after the method of Brinell: after 2 hrs. at least 0.1023; after 48 hrs. 0.2437. Tensile strength: after 3 days 15 kg./sq. cm.; after 7 days 20 kg./sq. cm.; after 28 days 30 kg./sq. cm. M.V.K.

Characteristics and testing of lime and cement colors. C. R. PLATZMANN. *Baumarkt*, p. 30 (1928); *Rock Prod.*, **32** [26], 96 (1929).—P. describes various colors and their application for coloring construction work made with lime and cement. W.W.M.

New Japanese cement specifications. ANON. *Zement*, **18,** 42 (1929); *Rock Prod.*, **32** [26], 98 (1929).—Japanese Portland cement specifications for 1929, as revised from those of 1927 are given. W.W.M.

Deviations in cement-testing results. PALOMAR. *Cemento*, **1,** 6 (1929); *Rock Prod.*, **33** [2], 82 (1930).—P. states that deviations in results of cement tests in various laboratories are over 50% in some cases. He suggests international standardization of testing apparatus and procedures, and a central testing laboratory for Spain. W.W.M.

Electrical dust precipitators. ANON. *Rev. mat. constr. trav. pub.*, No. 226, pp. 264–66 (1928); *Rock Prod.*, **32** [25], 93 (1929).—After several years' experimentation with different types of dust collectors, La Société de Chaux et Cimento du Languedoc, operating a limestone crushing plant and Portland cement mill at Ranteil, France, has installed electrical dust precipitators. The precipitators were supplied by the

Société de Purification Industrielle des Gaz (S.P.I.G.). Installations were made between the suction fans and the discharge ends of two rock driers handling 10 to 15 T. each of stone per hour, the moisture of the stone being 10 to 15%. Driers were coal fired, and dust-laden waste gases, at about 176°F, were withdrawn by two 212-cu. ft. per second suction fans. Actual figures showed more than 96% efficiency. Six tons of dust were recovered in one 18-hour run with a consumption of 1.5 kw. per hour. Precipitators were installed at the discharge end of the crushers, handling 141 cu. ft. of dust-laden air per second and recovering 1320 pounds of dust per hour with 1.5 kw. consumed per hour. Precipitators were connected with the raw and finish cement grinding mills with capacities of 8 and 4 T. per hour, respectively. These precipitators drop the dust directly in the silos. They handle 106 cu. ft. per second of cement dust-laden air and recover about 6½ T. of dust per 20 hours. W.W.M.

Feeding cement slip into rotary kilns. ERICH SHIRM. *Tonind.-Ztg.*, **54** [1], 8–11 (1930).—American, English, and German apparatus for feeding cement slip into rotary kilns are compared and their defects and merits pointed out. M.V.K.

Manufacture of cement in France. BLIN. *Technique Moderne*, No. 6 (1929); *Rock Prod.*, **33** [2], 82 (1930).—B. describes the French processes for manufacture of "grappier" cement, slag cement, natural Portland cement, white cement, and iron Portland cement. W.W.M.

French cement industry and its standards. H. PASSOW. *Zement*, **33**, 994–96 (1929); *Tonind.-Ztg.*, **53** [102–103], 1804 (1929). M.V.K.

Japanese research on cements. ANON. *Rock Prod.*, **33** [2], 56–59 (1930).—A number of abstracts from articles appearing in the *Journal of the Society of Chemical Industry* (Japan) are printed, covering some recent contributions to the chemical technology of Portland and other cements. W.W.M.

Governmental regulations for special cements in Italy. ANON. *Giorn. chim. ind. applicata*, **11** [5], 241 (1929).—Regulations for the acceptance of special cements and for the composition of concrete of these cements are now officially established in Italy. These include (1) aluminous cements which must contain at least 35% of alumina; (2) cements of high resistance containing marls or mixtures of calcareous and argillaceous materials; (3) blast-furnace cements, mixtures of pure pulverized clinker prepared from slow-setting cement and basic slag; (4) pozzuolana cement made from pure clinker cement and pozzuolana of acid reaction. None of these cements may contain more than 3% MgO (the blast-furnace cement may not have over 5% MnO) nor more than 1.5% SO_3; the addition of inert material is forbidden. Certain physical and mechanical characteristics both of the slow-setting cements and hydraulic concrete must also be guaranteed by producers: specific gravity 3.05; maximum residue with 900-mesh sieve, 2%; 4900-mesh sieve 15%. Time of hardening from 1 to 4 or 7 hrs. for aluminous cements and from 1 to 6 or 10 hrs. for high-resistant cements. Minimum resistance in kg./sq. cm. of normal mortar 1:3, for aluminous cements: (*a*) to tension: after 2 days, 25; after 7 days, 30; after 28 days, 35; (*b*) to pressure: after 2 days, 350; after 7 days, 450; after 28 days, 500. For high-resistant cement: resistance to tension: after 3 days, 20; after 7 days, 25; after 28 days, 30. Resistance to pressure: after 3 days, 250; after 7 days, 350; after 28 days, 500. M.V.K.

Gypsum molds for making tile. H. DENDL. *Tonind.-Ztg.*, **53** [104], 1805–10 (1929).—The casting and pressing processes for preparing gypsum molds are outlined. Molds made by the pressing process are more commonly used as they are not only more resistant but are more easily prepared. M.V.K.

Cement industry in 1928. ANON. *Tonind.-Ztg.*, **53** [99], 1743–44 (1929).—A report published by the League of Nations giving comparative statistics on the produc-

tion, consumption, exportation and importation of cement in 76 different countries for 1928. M.V.K.

BOOKS

Chemistry of Cement in Theory and Practice. HANS KÜHL. Zement and Beton. Berlin. 92 pp. 28 illustrations. 4.50 Rm. Reviewed in *Tonind.-Ztg.*, **54** [3], 49 (1930).—The six lectures given by K. in Moscow are published in book form and treat the following subjects: (1) *History.* The first methods of investigation used to solve the problem of the formation and hardening of cement (the analytical and mineralogical-petrographic) were found inadequate and physical chemistry was then tried. It is divided into the "static" investigation of the "equilibrium" and the "dynamic" investigation of the process of the formation of the presupposed silicates and aluminates in clinker. K. explains his own synthetic-technical method in which the synthetically-produced materials (although only in small quantities) will be tried on the main property of Portland cement, the hardening by water. (2) *Theory of cement firing.* The discovery made by White of the use of glycerine as a reagent for uncombined lime and the use of ammonium acetate in alcoholic solution (Emley) made possible the work of Monath and Lorenz, who proved that fired clinker does not contain uncombined lime. The great importance of iron oxides on the course of the firing process is discussed and the appearance of red brown clinker is explained. (3) *Constitution of Portland cement.* K. deals with the petrographical work of Le Chatelier, Törnbohms, and Glasenapp, which served as a foundation for the latest researches of Guttmann and Gille. A detailed discussion of alite including the question of "jäneckeit" follows. K. refuses to accept as is known, that jäneckeit is an important ingredient of clinker and stands for the existence of the tricalcium silicates. The description which K. gives of the jäneckeit controversy is brief but clear and comprehensive, as is the treatment of the researches of Dyckerhoff, who believes alite to be a solution of CaO in dicalcium silicate. This supposition is not tenable as it presupposes an uncombined lime, which does not exist in clinker. K. conceives alite to be a succession of mixtures of tricalcium silicate and jäneckeit; but does not entirely refute the explanations of Guttmann and Gille, whose newest results indicate the probable presence of small quantities of tricalcium aluminate besides tricalcium silicate in alite. Giving a short analysis of the composition of belite (existing mainly in all clinker) and the more important celite, K. closes with the assertion that the 3 substances tricalcium silicate, dicalcium aluminate, and dicalcium ferrite, or, in other words, alite and celite, form the ingredients of an ideal Portland cement. (4) *Hardening and its importance.* The experiments of Ambrons 20 years ago, led to a succession of valuable achievements in the field of microscopic research, which showed that the reaction between cement granules and water produces crystalline as well as colloidal substances. Which influences the hardening? In the opinion of K., the syntheses lead to the fallacy that the hardening depends on the matting of the crystalline structure. The cement granules act differently when mixed with a large quantity of water or with a small quantity; in the two cases the conditions for hydrolysis are fundamentally different. Only those experimental conditions which are at least similar to the practical conditions can be used for the solution of the problem of hardening. The theory of K. is that first of all around every cement grain a jell is formed which gradually shrinks as the water is absorbed from it with the subsequent transformation of the remaining particle of the cement grain into jelly, a process which may continue many years, before there is complete disintegration. The slow transformation of colloids by formation of crystals takes place later. The chemical character of the unstable jelly which is formed is explained, and K. concludes that the hardened cement consists mainly of colloidal dicalcium-hydrosilicates, tricalcium-hydro-aluminates, calcium hydrate, and calcium ferrite, which change into

crystalloids very slowly, the last to change being calcium hydrosilicate. With a short allusion to the newest work of Gessner on the steam pressure isotherm of hardened cement this instructive report is closed. (5) and (6). The two remaining chapters treat the theory and practice of cements of high quality, with reference first to the chemistry of these cements. K. believes that the determination of the right amount of lime is the most important question in the production of cement of high quality, and that this can be obtained in a composition of the raw material which guarantees the most complete formation of alite and celite by firing. The silicate modulus of the raw mass is not less important, as the highest and lowest values, having the same lime content, showed greater solidity than the intermediate values. Here follows a discussion of the firing process with regard to the great importance of thorough vitrification and its relation to the fineness of grinding of the raw materials. A discussion of the fineness of grinding of clinker, the fineness of gypsum admixtures, the action of other admixtures, as calcium chloride and similar catalyzers, opens the last report, the technique of cements of high quality. As a fundamental condition for a successful production K. emphasizes the use of good raw materials. The calculation of the lime content of the raw composition must be based on our knowledge of the composition of an ideal Portland cement. The formulas of Jänecke, Guttmann, Gille, and Kühl are given. That of Jänecke gives a very low hydraulic modulus, while the last two agree in this respect, as well as with practical experience. It is necessary to ascertain the exact content of the proportion of all raw materials; the ways for this are discussed. Preparation of homogeneous raw material, firing process, and the grinding of clinker are considered important factors in the production. The grinding of clinker is especially important and should not exceed a certain degree of fineness, a circumstance which the above outlined jell theory of K. supports. The report closes with a complete discussion of the newest devices for studying the grain size in powdered cement. The reader will find in the 92 pages of this book a quantity of very interesting material. See abstracts by Guttmann and Gille, and Jänecke, *Ceram. Abs.*, (this issue) pp. 254–55. M.V.K.

Action of Various Agents on Concrete. KLEINLOGEL, HUNDESHAGEN, AND O. GRAF. Wilh. Ernst and Sohn, Berlin, 1929. *Tonind.-Ztg.*, **54** [4], 64 (1930).—Of special interest in the book are the chapters on elasticity of cement and cement mortar, and the effects on concrete of certain agents: electricity, earthquakes and shaking, frost and cool weather, green fodder, and sea water. The aggregate composition of concrete and other theoretical discussions combined with practical hints on efficient working methods contribute to the interest and value of the work. M.V.K.

Retrogressions of Strength of Cement and Concrete; Results of the Discussion of Kl-Storage. GENSBAUR. Baumarkt, Leipzig. 70 pp. Price 9.30 Rm. Reviewed in *Baumarkt*, **28**, 48 (1929); *Rock Prod.*, **33** [2], 82 (1930). W.W.M.

PATENTS

Fused Portland cement from blast-furnace slag and limestone. OTTO KEUNE. Ger. 482,327; *Rock Prod.*, **32** [26], 97 (1929).—This process for producing Portland cement employs comparatively easily fusible substances as dissolving agents for the components which enter into reaction. With a fusion mass of 120 parts limestone, 10 parts calcium chloride, and 20 parts fluorspar, which may be prepared at a kiln temperature of 2552°F, there can be mixed 100 parts of fused blast-furnace slag directly under conditions which assure a complete homogenization. This eliminates otherwise necessary preparation of raw materials; the heat content of the fluid slag is utilized and the production temperature is comparatively low. Cement produced by grinding 20 parts of this fused cement clinker, 78 parts granulated blast-furnace slag and two parts raw gypsum showed, in testing, a normal set, volume consistency, and mortar strengths 60% above the minimum required for Portland cement. W.W.M.

Alumina cement. U. B. VOISIN. Ger. 482,185; *Rock Prod.*, **32** [26], 97 (1929).—This process employs bauxite-limestone or bauxite-lime mixtures which are leaner in CaO than the mixtures employed thus far in making alumina cements. The CaO content of the ultimate product is at most equal to one-half of the sum of the contents of the silica and alumina. The difference between the fusion and softening points of these mixtures is much greater than in those employed thus far. The new mixtures may be clinkered at 2192 to 2732°F without danger of portional fusions, whereas the average per cent composition of alumina cement used thus far is $10SiO_2$, $40Al_2O_3$, $10Fe_2O_3$, and 40CaO. The composition of a cement clinkered according to this patent is $5SiO_2$, $55Al_2O_3$, $15Fe_2O_3$, and 25CaO. This composition corresponds to a raw mix of 75% bauxite and 25% high calcium slaked lime at equal volume. W.W.M.

Enamels

Enamels. ANON. *Bull. Assn. Documentation; Emaillewaren-Ind.*, **6** [47], 390 (1929).—After discussing ordinary enamels for tin, cast iron, copper, etc., and the usual working process, the preparation of white, opaque, or colored, as well as transparent enamels by Migeot Brothers and Arnoult is described. Barium oxide or strontium oxide is substituted for lead oxide or zinc oxide, thus avoiding the lead poison and possible devitrification of enamel containing much zinc oxide. A good enamel is obtained and the transparency is guaranteed. M.V.K.

Production costs on enameling furnaces. R. A. BEVERLEY. *Ceram. Ind.*, **14** [2], 199 (1930).—A series of comparative costs have been prepared for the guidance of those interested in the installation of enameling furnaces. It is understood that these costs cannot be accepted as being representative of those which will be found to exist in all plants; the varied items being enameled by the wet process today, make such a cost summary a compilation requiring the efforts of many cost accountants. The figures presented, however, furnish a sound basis for preparing comparisons for any specific plant or conditions, including those of fuel and labor. The figures given are based upon actual records believed to be representative of one branch of the industry and are in such form that they may be readily adjusted to suit the needs of other branches. F.P.H.

Electric rotary kiln. VIELHABER. *Emaillewaren-Ind.*, **6** [48], 395–96 (1929); *Tonind.-Ztg.*, **53** [104], 1821 (1929).—The first tunnel kilns constructed for enamel works were after the model of ceramic tunnel kilns; the ware went straight through in one direction. For enamel kilns a construction was necessary which would make possible the transportation of ware without trucks; further, it was a question of preventing the great loss of heat which results from the two ends being open in the continuous process. This last problem is solved by the rotary kiln where the entrance and outlet are side by side. The ware turns in the firing zone and is carried back in a second tunnel. The sudden change of direction avoids the draft and the hot ware going out transfers its heat to the ware which is coming in from the opposite direction, as the tunnels are adjacent. A further development is the raising of the tunnel floor from the entrance and outlet end to the firing zone. The General Electric Co. has such a rotary kiln heated by electricity. The furnace described is provided with a system for transporting the ware on suspended platforms. M.V.K.

Synthesis of enamels. A. THÜRMER. *Glashütte*, **59** [51], 929–31 (1929).—T. cites several formulas and discusses them from the standpoint of the properties of the enamel. L.T.B.

Enameling plant of the Mullins Manufacturing Co., Salem, Ohio. ANON. *Ceram. Ind.*, **14** [2], 200–204 (1930). F.P.H.

Metallurgia. (Monthly). Kennedy Press, Manchester, England. Price 2s 6d monthly. A new journal dealing with new alloys, blast-furnace practice, and methods of heat treatment. H.H.S.

BOOK

Enamel Production. LUDWIG STUCKERT. Julius Springer, Berlin, 1929. Price 29Rm. *Tonind.-Ztg.*, **54** [4], 64 (1930).—In this book S. has included every important question relating to the production of enamel: (1) historical development of the technique of enamel; (2) chemical and physical properties, as far as they are known; (3) preparation of enamel; (4) raw and auxiliary materials needed for the composition of enamels; (5) different kinds of enamels and their use for the enameling of tin, cast iron, and other metals; (6) different methods of coating objects with enamels; (7) preparation of enameled objects; and (8) organization of an enamel factory. Illustrated. M.V.K.

PATENTS

Tile and fixture mounting. WILLIAM G. WEBSTER. U. S. 1,744,187, Jan. 21, 1930. A tile wall and fixture construction comprising a supporting wall, a fixture having a rectangular base adapted to rest against the wall, a securing member integral with the rectangular portion and projecting laterally from the portion along the wall and secured thereto, a foundation sheet secured to the wall and having an aperture therein in which the base fits, and a plurality of tile abutting the rectangular base and secured to the foundation sheet, the member being of less thickness than the base and being concealed beneath the tile.

Producing cast iron of any desired structure. FRITZ GREINER. U. S. 1,746,467, Feb. 11, 1930. Method of making a casting having different wall thicknesses, to produce the same microstructure in walls of different thickness, which comprises using for the casting, mixtures having a content of C + Si regulated in accordance with a chart on which percent of C + Si is plotted against wall thickness, the chart being divided into fields corresponding to the different classes of microstructure and defined by curves converging substantially toward the point whose coördinates are 0 mm. wall thickness, 7.0% C + Si, from the various points along the line 4.0% C + Si representing the wall thicknesses 6.0 mm., 12.5 mm., 51.5 mm., and 63.5 mm., the content of C + Si being selected so that the crossings of the line representing the content by the lines representing the two extremes of wall thickness in question both lie in a single field of the chart.

Removing grease from metal and other articles. CARRIER ENGINEERING CO., LTD., AND K. J. R. ROBERTSON. Brit. 322,797, Feb. 5, 1930. Grease is removed from metal and other articles by immersing them in or passing them through a vapor solvent for the grease while they are at a temperature below that of condensation of the vapor so that the vapor condenses on the articles and dissolves the grease, which falls off in solution and leaves the articles dry.

Glass

Feldspar used for glass manufacture in Canada. HUGH S. SPENCE. *Mining and Met.*, **11** [278], 103 (1930).—The Canadian feldspar production may be stimulated in the near future, owing to the erection at Oshawa, Ont., of a glass plant designed to use feldspar as practically the sole raw material. The company claims to have perfected all the technical details of manufacture, and expects to begin production early in 1930. Bottles, of the beverage and milk types, will constitute the output. The feldspar, ground to 60-mesh, is melted in a 40-ton, rectangular, melting furnace and is then run

to a circular refining furnace, from which the finished glass flows to the bottle machines. Both furnaces are heated electrically. It is claimed for the process that the production cost will be only a fraction of that of bottles made from the usual raw materials, and that the glass is much tougher than ordinary bottle glass. Mine-run feldspar is to be used, the presence of ferro-magnesian mineral impurities being no detriment; the laid-down cost from the company's own mines in the Perth district is estimated at $5.00 per ton. The estimated consumption of feldspar will be a carload per day, equivalent to 10,000 to 12,000 T. per year. F.P.H.

Permeability of glass to ultra-violet light. III. GOTTFRIED ROSE. *Glass Ind.*, **11** [2], 32–35 (1930).—Experiments made in an endeavor to discover whether the ratio $FeO:Fe_2O_3$ in the glass will be displaced toward divalent iron by the reducing agent and the reducing melt, remain constant, or be displaced toward Fe_2O_3, as well as experiments with commercial glasses by R. and others, are discussed. Incandescent lamp bulbs permeable to ultra-violet rays and their importance in medicine were studied. Results of the entire investigation show (1) permeability of a glass for ultra-violet light increases with decreasing ferric oxide content; (2) in addition to the total iron content, the state of oxidation of the iron is of very great importance for ultra-violet permeability; (3) ferrous oxide absorbs less strongly than ferric oxide; (4) ultra-violet absorption by trivalent iron in aqueous solution is about 100 times as great as the absorption by divalent iron; (5) the decrease in ultra-violet transmissive power under the influence of ultra-violet radiation, is due to a re-oxidation of the divalent iron; (6) the transformation of ferrous salt to ferric salt in aqueous solution is accelerated by radiation with ultra-violet light; and (7) using curves of ultra-violet permeability, it is possible to obtain an indication of the ratio of ferrous oxide to ferric oxide in glass with a low iron content, in which the methods for the determination of divalent and trivalent fail to give results. For Part II see *Ceram. Abs.*, **9** [2], 92 (1930). E.J.V.

Beneficial glass. W. F. *Diamant*, **51** [20], 382–84 (1929).—As the knowledge of the improved growth obtainable by the use of ultra-violet rays was gained, there came about a production of various glasses transparent to these rays. The production of this type of glass required materials of such high purity that the cost of glass was trebled. The ultra-violet ray transmitting glasses also lost their property of transmission with time and though heat would restore it, this was of little practical value. It has been stated that the Corning Glass Works has produced a good ultra-violet transmitting glass 2 mm. in thickness at only a trifle higher cost than that of producing window glass. Some grave doubts have been thrown on the efficacy of ultra-violet transparent glasses, as Janet H. Clark of Johns Hopkins University found a 5 mm. layer almost opaque to the rays. A few minutes in the open sun were better than many hours behind such glasses. E.J.V.

New safety glass. ANON. *Popular Sci. Monthly*, **116** [3], 30 (1930).—Xetal, a new safety glass said to be proof against fire, splintering, or discoloring has been patented by an English firm and subjected to rigorous laboratory tests. Firing service revolvers at the glass at distances of 10 and 25 yards resulted in a pulverizing of the glass to the depth of only one thirty-second of an inch. Exposure to the rays from a powerful mercury vapor lamp for 24 hours resulted in no discoloration of the glass, a decided contrast to ordinary glass, which the sun's rays will even discolor in the temperate zones. While resembling ordinary glass in appearance, Xetal can be made in any shape or size and in any thickness, from that of the best lens-making glass to the bullet-proof variety. E.J.V.

Ground-glass joints. ANON. *Commercial Stand. Monthly*, **6** [7], 215–16 (1930).—A conference of representative manufacturers and users of laboratory glassware proposed and adopted one standard specification for taper and diameter sizes of glass

joints. General acceptance of this specification by the industry is still to be obtained. These standard interchangeable joints will facilitate the setting up of complicated pieces of laboratory apparatus and will provide for quick substitution of broken parts, effecting vast economies over the older method of having to replace the entire apparatus. E.J.V.

Flow of glass in tanks. A. L. MARDEN. *Glass Ind.*, **11** [2], 31 (1930).—A series of investigations on the flow of glass in the tank of the Danner tube-drawing plant resulted in various improvements in the construction of the tank. The relation between certain faults in the tubing produced which had occurred from time to time and the conditions of flow in the tank were demonstrated, and it was shown how the practical application of this knowledge had led to improvement in production. E.J.V.

Gases in glass. III. ALFRED BECKER AND HERMANN SALMANG. *Glastech. Ber.*, **7** [6], 241–44 (1929).—Experiments on the gas content of five optical glasses were conducted. The reactions between the glass and gases were investigated. Details of how these experiments were conducted are given. Results obtained show (1) optical glasses contain considerable quantities of gas, most of all oxygen; (2) oxygen appears in the vacuum melting of glasses from sulphate-free mixtures, if an oxide which occurs in several degrees of oxidation is contained in the glass; (3) gases are absorbed by the glass if a stable compound can be formed under the conditions existing for the time being in the glass. This occurs on introduction of oxygen in FeO-containing melts, and $SO_2 + O_2$ further out of H_2S in acid soda-lime-silica melts. See also *Ceram. Abs.*, **7** [10], 672–73 (1928); *ibid.*, **8** [9], 643–44 (1929). E.J.V.

Heat-flow experiments on plate glass tank furnace fired with coke-oven gas. WERNER MÜLLENSIEFEN. *Glastech. Ber.*, **7** [5], 188–200 (1929).—A detailed account of heat-flow experiments on a tank furnace having a capacity of 75,000 sq. m. monthly is presented. All methods used in obtaining the data during the course of the experiments, data obtained, and all calculations are included in this report. Illustrated. E.J.V.

Possibilities of mixture compression. G. KEPPELER. *Glastech. Ber.*, **7** [4], 135–43 (1929).—Every mixture, even the practically completely mixed, can disintegrate or separate into its component parts on the way to the bins, in removal from the bin, or on the way from the bin to the furnace. Also, due to the dusting and evaporation of individual components of the mixture its composition is altered, and accordingly the desired homogeneity of the melt is made more difficult to obtain due to the nonuniform melting of the mixture components. To avoid these difficulties, possibilities of compression of mixtures were investigated. There are three possibilities which could be used. (1) There is the simple mechanical compression by comparatively great pressures, briquetting without binders. The various components of the mixtures behave differently on pressing. There seems to be a rough relation between the adaptability to briquetting and the hardness of the materials. The effect of the water content of the raw material, especially the water which may combine chemically, is very noticeable. On this account differently compounded mixtures exhibit different behaviors on pressing, and the finished briquets in storage do likewise. (2) Briquetting with the aid of binders requires less pressure. This method is less suitable because many binders are difficult to use due to their reducing effect on the melting glass, and also because the solution of the water-soluble constituents in the mixture may alter the composition. Another difficulty is the need for dies, generally of iron or steel, and this may cause a contamination of the mixture with iron. (3) Taking a loosely compressed batch and heating it to a point below the melting point of the lowest fusing component, or sintering it, is a third method. By heating to a point between 700° and 800° the CO_2 in the carbonates is practically completely expelled, the loosely-

packed material shrinks further, becomes denser, and holds together well, and on complete melting a homogeneous glass is obtained. It is suggested that by sintering the batch in this way and by utilizing the waste heat from a glass furnace, the thermal efficiency of the latter can be increased and a nearly continuous melting process can be developed. E.J.V.

Acid polishing of glass. F-x. *Diamant*, **51** [17], 327–28(1929).—Acid polishing of glass is nothing less than a chemical etching process. It dates back to 1870 when a Nürnberger, Schwanhardt, observed the etching effect of a mixture of sulphuric acid and fluorspar on glass. The polishing process is discussed and a method of preparing an acid polishing bath is given. A resistant for line etching consists of 500 asphaltum, 200 Venetian turpentine, 250 resin, and 180 yellow beeswax, dissolved in 1000 parts of turps. E.J.V.

Mirror surface lacquers. MAX ERMES. *Diamant*, **51** [15], 286–88 (1929).—The properties of some of the varnishes or lacquers used in the mirror industry are discussed. Varnishes containing alcohol are not used for silver mirrors as the residual alcohol causes them to be hygroscopic to some extent, while benzol varnishes are not good in cold weather since the resin is decomposed and drying is held up. No alternative solvents are suggested. E.J.V.

Production of protective coatings for silvered mirrors by electrodeposition. T. J. K. *Diamant*, **51** [16], 303–304 (1929).—An outline description of a series of electroplating baths so arranged as to maintain the one used for backing the silver coating in a neutral condition is given and explained with the aid of a diagram. E.J.V.

Basic oxides and properties of glass. NORBERT KREIDL. *Glass Ind.*, **11** [2], 25–28 (1930); translated from *Glastech. Ber.*, **7** [8], 313–17 (1929); see also *Ceram. Abs.*, **9** [2], 89 (1930). E.J.V.

Glass batch mixing machinery. H. K. DE WEERDT. *Glastech. Ber.*, **7** [4], 125–35 (1929).—As homogeneity of mixing of the batch and uniformity of size of the particles in the batch have considerable effect on the ease of melting of the glass and the homogeneity of the resultant melt, it is important to use the best mixing system possible. Mixing machinery is divided into three types: (1) barrel mixers with built-in mixing elements, (2) horizontal trough mixers, and (3) disk or pan mixers. The different types are discussed as to construction, advantages, disadvantages, etc. The choice of the machinery is dependent on many variables so no one type can be recommended unqualifiedly. Each must fit the particular problem encountered. E.J.V.

Glass bulb industry. ANON. *Glass Ind.*, **11** [1], 11 (1930).—The production of glass bulbs for 1929 reached nearly three-quarters of a billion and is still increasing in volume. Improvements have more than doubled the output of the Westlake machine, one modified machine producing 110,000 standard lamp bulbs per day of 24 hrs. A new method is in use by the Corning Glass Works which gives a production exceeding 300,000 bulbs a day. A new method for the inside frosting of bulbs greatly reduced the time required for that operation and put it on a mass-production basis. The principal manufacturers of glass bulbs in the U.S. are the Corning Glass Works which produces bulbs at several plants, and the Incandescent Lamp Dept., General Electric Co., which controls the National Lamp Works at Nela Park, Cleveland, and several other factories. The consumption of glass bulbs in the U.S. in 1929 shows an increase of 23% over that for 1928. E.J.V.

Continental plate glass agreement. ANON. *Frankfurter Z.; Pottery Gaz.*, **55** [632], 315 (1930).—An agreement between the Cologne plate glass concern and the Schott optical glass concern has been reached. The Cologne plate glass factory will now produce optical glass only. The plants are situated in Grünenplan and Mitterteich. E.J.V.

National Plate Glass Co. ANON. *Ceram. Ind.*, **14** [2], 166–85 (1930).—The National Plate Glass Co.'s new plant at Ottawa, Ill., is the first plant to put in operation a completely mechanical and automatic system of rolling, annealing, grinding, and polishing plate glass. Sheets as long as 100 ft. have been rolled. The leer is electrically heated and is 728 ft. long. Ware is annealed in slightly over one hour. Pots are poured at the rate of one every seven minutes. Glass coming out of the leer is absolutely straight. Twenty-four million square feet annually is the plant capacity. The entire process from raw materials to finished sheet requires only 36 hrs. The pots are preheated in an oil-fired tunnel kiln built especially for that purpose. There is no cooling zone in the kiln, the pots being taken from the kiln immediately after they have passed through the firing zone, and placed in the pot furnaces. The pots are heated to about 1600°F in the kiln. The kiln has a capacity of about 21 pots daily. Each pot is good for about 20 melts. Each furnace holds 16 pots, 8 on each side and firing is done with producer gas. The glass is cast by the Bicheroux process which employs a double roll for forming the sheet instead of the old method of pouring the glass on a casting table and rolling it with a single roll. F.P.H.

Durability experiments with glass. OTTO GRAF. *Glastech. Ber.*, **7** [4], 143–46 (1929).—Experiments in loading square plates of glass of known thickness with definite loads to determine how long the load must be applied before failure of the glass are described. From the data obtained the durability of the glass is calculated. Illustrated. E.J.V.

History of colored glass. S. R. SCHOLES. *Glass Ind.*, **11** [2], 28–29 (1930).—Colored glass was probably the first sort to be made anywhere, due very probably to the lack of pure materials, or adequate skill in handling decolorizers. Few of the really ancient formulas have come down to us but toward the end of the 18th Century, there seems to have been some research on colored glasses owing to the urge for the imitation of precious stones. An abstract of an account of some of these studies written by a Frenchman named Fontanieu, and translated into German by "D.R.," published in 1781, is given. Methods and recipes are contained in the account. E.J.V.

History of glass industry in Vienna. ALBERT ILG. *Glastech. Ber.*, **7** [5], 180–82 (1929).—A brief history of Viennese glasswork, from the 12th Century to the 16th Century is presented, some of the better known glass workers of that time being enumerated and their work discussed. E.J.V.

Glass and concrete building designed. FRANK L. WRIGHT. *Glass Ind.*, **11** [2], 47 (1930); *Christian Sci. Mon.*, **22** [62], 3 (1930); *Nat. Glass Budget*, **45** [40], 26 (1930).—A building of revolutionary character composed practically altogether of concrete, copper, and glass has been designed. The structure will rise eighteen stories with a two-story pent-house at the top. The entire building is to be supported on a central core, the whole resting on a concrete base set in bedrock. From the central core of the building shelves or floors will extend and over these shelves the glass and copper shell will be constructed, the walls consisting entirely of heavy plate glass and the necessary copper fittings to hold it in place. No structural steel will be employed. Illustrated. E.J.V.

Kitchen enclosed by glass. ANON. *Nat. Glass Budget*, **45** [40], 10 (1930).—One of the unique features of the Merchandise Mart at Chicago is that more than 30,000 square feet of space in the Mart's grand lobby will be divided into four units and is to be utilized for restaurant purposes. These will be grouped about a huge kitchen, enclosed by glass. E.P.R.

Hartford-Empire experimental plant. ANON. *Glass Ind.*, **11** [2], 45 (1930).—A modern glass plant, to be operated exclusively for experimental and development purposes, is being built for the Hartford-Empire Co., at Hartford, Conn. The plant will

be equipped with all modern facilities which will permit the Hartford company to carry on an extensive development program. New inventions, processes, and machines will be developed under the guidance of the engineering and scientific staffs of the Hartford Empire Company. Illustrated. E.J.V.

New bottle factory for Venezuela. ANON. *Glass Ind.*, **11** [2], 48 (1930).—A new bottle factory with a capacity of 60,000 bottles per day is to be erected by the Compania Anonima Manufacturera De Vidrio Y Cristal, Caracas, Venezuela, S. A. It is the intention to operate six O'Neill machines, and investigations of various types of equipment including furnaces, leers, fuel oil burners, etc., are being made in America with a view toward selecting the most modern equipment for the new plant. Heretofore all supplies have been bought from England, but an active interest in quotations on American chemicals is now being displayed. E.J.V.

Plate glass production in 1929. P. A. HUGHES. *Glass Ind.*, **11** [2], 48 (1930).—The production of polished plate glass in the U. S. in 1929 exceeded any previous record. The total quantity produced was 150,498,287 sq. ft. Had not production fallen off heavily during the latter part of the year a still more remarkable record would have been achieved. December production was but 8,482,289 sq. ft. compared with the November figure of 12,130,845. The quarterly production was a follows: 1st quarter, 35,859,187; 2nd quarter, 37,614,956; 3rd quarter, 41,790,106; 4th quarter, 35,234,038 sq. ft. E.J.V.

Belgian glass industry. WILLIAM C. BURDETT. *Commerce Repts.*, **5**, 328–29 (1930).—The demand for Belgian plate glass has fallen off, but the trade depression in plate glass is much less acute than in window glass. Merger of all Belgian Fourcault sheet-glass plants is rapidly taking form and is accelerated by the present depression. E.J.V.

Czechoslovakian glass industry. SAM E. WOODS. *Commerce Repts.*, **4**, 260–61 (1930).—A summary of the condition of the industry in 1929 as compared with 1928 is given. See also *Ceram. Abs.*, **9** [3], 177 (1930). E.J.V.

Swedish glass manufacturers form export cartel. BASIL D. DAHL. *Commerce Repts.*, **4**, 261 (1930); *Amer. Glass Rev.*, **49** [18], 16 (1930).—The Swedish Glass Manufacturers Export Assn. has been formed for the purpose of promoting sale of member's products in certain export markets. A considerable export trade has been developed with ornamental glassware such as Orrefors and Kosta which has a world-wide reputation because of its high quality, artistic form, and beauty. See also *Ceram. Abs.*, **9** [3], 236 (1930). E.J.V.

Society of Glass Technology. ANON. *Pottery Gaz.*, **55** [632], 265–67 (1930); *Glass Ind.*, **11** [2], 37–38 (1930).—A report of the meeting held at South Kensington, on Dec. 18, 1929, is given. Papers read at the meeting included "The Annealing of Glassware," by J. B. Murgatroyd; "The Strength of Thermally-Toughened Glass," by J. T. Littleton, Jr., and F. W. Preston; and "The Strength of Cracked Glasses," by Lowell H. Milligan. For abstract on previous meeting see *Ceram. Abs.*, **9** [2], 95 (1930). E.J.V.

PATENTS

Severing glass sheets. HOWARD L. HALBACH. U. S. 1,744,045, Jan. 21, 1930. Apparatus for separating the edge of an upwardly moving sheet of glass, which comprises a clamping member extending transversely of the sheet and free to move with the sheet, a heating element extending longitudinally of the clamping member, a second heating element extending longitudinally of the sheet adjacent the edge thereof and supported at its lower end upon the clamping member, means for intermittently clamping the member against the glass so that it moves along with the glass, spring means holding the upper end of the second heating element in advance of its lower end and

in advance of the first-mentioned heating element, and means for causing a flow of electric current through both of the elements to heat them.

Severing edges of glass sheets. HOWARD L. HALBACH AND DON R. LIMBERS. U. S. 1,744,046, Jan. 21, 1930. Apparatus for separating the edge of an upwardly moving sheet of glass, comprising a heating element extending longitudinally of the sheet adjacent the edge thereof, a fixed supporting member, a second supporting member pivoted on the fixed member and carrying the heating element so that the element is free to adjust itself to the position of the sheet, and means for causing a flow of electric current through the element to heat it.

Glass-melting furnace. WILBUR F. BROWN. U. S. 1,744,359, Jan. 21, 1930. The combination with a glass-melting furnace adapted to contain molten glass and including a melting tank having a reduced neck portion at one end thereof, of means arranged within the neck portion and disposed within the molten glass for straining the same as it flows therethrough.

Producing plate glass. JOHN L. DRAKE. U. S. 1,744,372, Jan. 21, 1930. In apparatus for producing plate glass, a plurality of movable tables, means for forming a series of glass blanks thereon, an annealing leer, means for carrying the tables in one direction through the leer to anneal the blanks and cool the tables, means for carrying the tables in the opposite direction back through the leer whereby to heat the same prior to the forming of another series of blanks thereon, and means for grinding and polishing one surface of the glass blanks after the cooling but prior to the heating of the tables and without removing the blanks therefrom.

Annealing glass. ENOCH T. FERNGREN. U. S. 1,744,377, Jan. 21, 1930. In a leer for annealing and cooling a continuous glass sheet, roller means for moving the sheet therethrough, means for releasing supplemental heat into the atmosphere along a portion of the leer, sealing means for preventing draft currents of local character at the level of sheet, and means for causing local escape movement of heated atmosphere at different levels below the sheet.

Draw pot. WILLIAM S. MCKINLEY. U. S. 1,744,406, Jan. 21, 1930. A glass tank furnace, including a cooling chamber, a draw pot, a gooseneck attached to the cooling chamber, the inner bottom surface having a gradual upward slope terminating at a slot in the end thereof, and an extending lip on the draw pot bottom disposed within the slot, the upper surface of the lip beveled off to conform with the slope of the gooseneck bottom, forming a continuation thereof.

Cooling and annealing of glass in strip form. ERNEST BRISTOW LE MARE. U. S. 1,744,478, Jan. 21, 1930. Process of cooling continuous glass strip in a leer in which products of gaseous combustion are introduced into portions of the leer both above and below the glass strip near the entrance end of the leer, the amount of heat thereby supplied to the upper surfaces of the edge portions of the strip relatively to that supplied to their lower surfaces being controlled, and the amount of heat supplied to the upper surface of the central portion of strip relatively to that supplied to its lower surface being independently controlled, the controls being to secure "symmetrical cooling" before the strip "solidifies" and withdrawing the products by flues which are independent for the upper and lower portions of the leer.

Glass-fabricating machine. ROSWELL F. HATCH. U. S. 1,745,794, Feb. 4, 1930. In a glass-fabricating machine, the combination of a fixed parison mold, a slidably mounted blow mold, means for transferring the parison from the parison mold to the blow mold, means for periodically moving the blow mold into and away from the transfer position, and blowing means moving with the blow mold for blowing the parison in the blow mold while the latter is moving away from its transfer position.

Glass-polishing apparatus. CHARLES HEUZE. U. S. 1,746,472, Feb. 11, 1930. In

continuous glass-polishing apparatus in which both the glass and the polishing runners travel, the combination with a plurality of runner frames of a plurality of fixed tanks adapted to contain polishing media, a trough attached to each runner frame adapted to receive the media from the tanks during its travel and long enough to receive polishing medium for a considerable part of the time of travel of the runner frame from one tank to the next, and means conducting the media from each receptacle to the polishing pads of the runner frame.

Making plate glass. CHARLES D. DAVIS AND EDWIN L. YEWELL. U. S. 1,746,695, Feb. 11, 1930. An apparatus for drawing plate glass in the flat embodying a container for the molten glass, a bait, a supply of metallic wire adjacent each end of the bait, the free end of the wire being adapted to be connected to the adjacent end of the bait, and means for continuously guiding and pressing the wire into the edge of the sheet while the same is in a soft condition, the means embodying a roller over which the wire runs and means for positively and adjustably holding this roller in contact with the edge of the sheet.

Sealing laminated glass. THOMAS H. POWERS FARR, JR. U. S. 1,746,826, Feb. 11, 1930. Method of filling with sealing material a slot in the edge of laminated glass, which comprises reducing the air pressure in the sealing slot and immersing the glass in a bath of sealing material while the pressure is still reduced.

Glass gob cutter. CHARLES H. SCHMALZ. U. S. 1,747,087, Feb. 11, 1930. A gob cutter for glass machines adapted to be positioned near the outflow of glass from a melting tank, the cutter including a hollow annular body formed with an annular discharge slit positioned to discharge toward a central point, the body being positioned so that the glass passing from the melting tank will flow axially through the center of the annular body, a pair of inlet pipes connected to the body on diametrically opposite sides and positioned to discharge gaseous matter into the hollow body at a tangent, the pipes being connected together, a supply pipe connected to the pipes at their point of juncture, and a three-way valve positioned at the point of juncture for causing gaseous matter to flow through either of the pipes independently, both pipes simultaneously and shut off the supply of gaseous matter according to the position of the valve key.

Device for cutting sheet glass. LAMBERT VON REIS. U. S. 1,747,270, Feb. 18, 1930. A device for cutting plastic sheet glass while in movement, comprising a rotatable body member above the path of movement of the glass, straight-cutting blades arranged transversely and projecting upwardly of the path of movement, and cutting blades formed on the body member along a helical line around the axis of the member, these helical blades being adapted to coact with the straight-cutting blades to divide the glass from one of its side edges to the other when the body member is rotated.

Automatic bottle-blowing machine. HANS HILLMANN. U. S. 1,747,438, Feb. 18, 1930. (1) Automatic glass-blowing apparatus for blowing articles of different sizes comprising in combination, a basin containing molten glass, a rotary support arranged for angular movement relative to the basin, gathering and molding means on the support, automatic means comprising instrumentalities for controlling first the operation of one of the means and after a predetermined angular movement of the support also the operation of the other means, and a single control means for varying the extent of the movement and the sequential operation of the other means to adapt same to the different rate of cooling of the different kinds of products to be blown. (2) Automatic glass-blowing machine comprising in combination, a central structure, a neck mold, a blank mold below the neck mold, and a finishing mold below the blank mold, all the molds being movable together about the center of the structure, and automatic means for opening the blank mold and for lowering the neck mold toward the finishing mold across the opened blank mold.

Silvering glass knobs. GEORGE GLAUDEL. U. S. 1,747,704, Feb. 18, 1930. Method of silvering knobs, which comprises placing a plurality of knobs in a tray with the ends requiring silvering extending through closely fitting apertures in the bottom of the tray and against a moistened felt guide, pouring a molten material into the tray about the knobs to retain the knobs in position and to seal the apertures, inverting the tray and contained knobs after the molten material has solidified, cleaning the thus exposed surface of the knobs with a cleaning solution, then applying a silvering solution, permitting the silvering solution to stand upon the knobs for approximately one hour, drying the knobs, coating the silvered surfaces of the knobs with shellac while still retained within the tray, and then melting off the solidified material.

Making laminated glass. JAMES W. H. RANDALL. U. S. 1,748,079, Feb. 25, 1930. As a new article of manufacture, a sheet of laminated glass including a sheet of glass and a sheet of cured rubber united thereto.

Making translucent laminated glass. JOSEPH A. REECE. U. S. 1,748,080, Feb. 25, 1930. As a new article of manufacture, a sheet of laminated glass comprising a plurality of laminations bonded together, the outer surface of at least one of the outer laminations being relatively rough and the inner surface of the respective lamination being smooth.

Sheet glass surfacing apparatus. JOSEPH P. CROWLEY. U. S. 1,748,112, Feb. 25, 1930. A runner construction for use in machines for polishing flat glass, including a rotatable runner frame, an outer annular series of polishing blocks carried by the frame and being of a uniform size, a second annular series of polishing blocks carried by the frame inwardly of the first series and being of a plurality of sizes alternately arranged, a third annular series of polishing blocks carried by the frame inwardly of the second series and being also of different sizes alternately arranged, and a fourth annular series of polishing blocks carried by the frame inwardly of the third series and being of a uniform size.

Producing sheet or plate glass. JOHN L. DRAKE. U. S. 1,748,115, Feb. 25, 1930. In an apparatus for producing sheets of glass, comprising a receptacle containing molten glass, means for longitudinally indexing the receptacle, a plurality of annealing leers in close proximity thereto, a carriage longitudinally indexing the receptacle, a plurality of members attached to the carriage, means for alternately dipping the members in the molten glass, means for forming sheets of glass in the members from the molten glass, reciprocatory means for conveying the sheets thus formed to their respective leers, means for removing the sheets from the members, and means for feeding the sheets into the leers.

Annealing sheet glass. JOHN L. DRAKE. U. S. 1,748,116, Feb. 25, 1930. In apparatus for annealing sheet glass, a leer for receiving a moving sheet to be annealed, and a powdered material surrounding the moving sheet and contacting therewith within the leer for preventing a too rapid dissipation of the heat therefrom.

Severing molten glass. GEORGE R. HAUB. U. S. 1,748,550, Feb. 25, 1930. In a glass feeder, a flow spout having an outlet, a chamber for an explosive fluid adjacent the outlet, intermittently operated means for admitting an explosive fluid to the chamber, means synchronized with the first-mentioned means for permitting the discharge of the fluid from the chamber, and guiding means for directing the fluid in a thin sheet against the glass protruding from the outlet.

Window glass, etc. ANDERSON B. SMEDLEY. U. S. 1,748,587, Feb. 25, 1930. As a new article of manufacture a heat-insulating and light-diffusing glass comprising a body having gas-filled bubbles and substantially smooth outer faces.

Compound transparent sheets. P. H. HEAD. Brit. 321,977, Jan. 15, 1930. Ethyl lactate alone or in solution is used as a solvent of cellulose-derivative sheets to secure

adhesion to glass sheets when manufacturing compound transparencies. Methyl-cyclo-hexanone or triacetin may be added to the lactate to render sealing of the edges unnecessary or the edges may be grooved and filled with copaiba oil or china wood oil which is dried by heating, or the edges may be sealed by burning or cauterizing the cellulose sheet. An example of a suitable solvent consists of ethyl lactate 35%, methylated spirit 35%, diacetone alcohol 10%, triacetin or methyl-cyclo-hexanone 20%. The sheets may be treated by immersion in a bath of ethyl lactate or otherwise and subsequently pressed in a hydraulic press with rubber platens. Brit. 299,900 is referred to.

Compound glass sheets. H. D. MURRAY AND D. A. SPENCER. Brit. 322,598, Jan. 29, 1930. To prevent discoloration by the sunlight of the celluloid used in composite glass, aesculin or a fluorescent salt of a cinchona alkaloid is used in the manufacture of the glass. A film of gelatine solution containing the fluorescent salt may be coated on the glass surface to contact with the celluloid. In addition to this the nitro-cellulose sheet may be impregnated with a substance which inhibits decomposition or which forms colorless compounds with the decomposition products of nitro-cellulose, *e.g.*, sodium silicate and glycerine and the celluloid used is of high viscosity. A further precaution is to use glass which is impermeable to ultra-violet light.

Glass rolling. A. E. WHITE. Brit. 322,620, Jan. 29, 1930. A method of making sheet glass consists in flowing molten glass from a tank furnace to the pass between a pair of rollers in a thin stream of substantially the same width as the sheet to be formed, and in cooling one surface of the molten glass before it reaches the pass so as to stiffen the surface. Reënforcing wire may be fed into the molten glass after the surface has been cooled so that the stiffened surface supports the wire.

Glass rolling. A. E. WHITE. Brit. 322,759, Feb. 5, 1930. Apparatus for making sheet glass is arranged to produce the sheet either in a continuous strip or in single sheets. In the former case, the sheet is carried through the leer at the same rate at which it is formed, and in the latter case, the sheets are rolled intermittently at a high speed and are passed directly onto a conveyer which carries them through the leer at a low speed.

Glass rolling. A. E. WHITE. Brit. 323,151, Feb. 12, 1930. Relates to the method of making plate or sheet glass in which a mass of glass is rolled between opposed rollers, as described in Brit. 269,300. According to the invention, a blast of air or steam is directed against the surface of the lower roller in such a manner that the front edge of a glass strip, as it emerges from between the rollers is lifted and slides easily onto the front edge of the runway that conveys it to the leer. The air blast may be used also as a cooling device while the rolling operation is in progress.

Molding glass. GAS ACCUMULATOR CO. (UNITED KINGDOM), LTD. Brit. 323,163, Feb. 12, 1930. Hollow profiled lenses, such as Fiesnel lenses, are made by subjecting a mass of molten glass in a mold to centrifugal force. The mold is made in three parts which fit onto a base and are clamped together by means of a sleeve. The base fits on a spindle which can be rotated rapidly. A mass of glass is placed in the mold, and when the mold is rotated, the glass distributes itself over the inner surface. Rotation of the mold is continued until the glass has set. The base may be formed with a conical portion extending upwards into the mold.

Use of specially tempered glass for windows and windshields of motor vehicles. COMPAGNIES RÉUNIÉS DES GLACES ET VERRES SPÉCIAUX DU NORD DE LA FRANCE. Brit. 310,838, May 1, 1928. (*C.A.*)

Apparatus for making rough glass. COMPAGNIE RÉUNIÉS DES GLACES ET VERRES SPÉCIAUX DU NORD DE LA FRANCE. Fr. 663,440, Feb. 20, 1928. (*C.A.*)

Reënforced glass. HENRY LEV. LAWRENCE AND THE KENILWORTH MANUFAC-

TURING CO., LTD. Fr. 663,992, Nov. 15, 1928. Sheets made of glass with an intervening sheet of celluloid or mica, etc., are united under heat and pressure by coating the glass surfaces with a solution of nitrocellulose combined with gums, elemi, and mastic and by coating the cellulose, etc., with a solution containing gums, elemi, and benzoin. (*C.A.*)

Glass. N. V. PHILIPS' GLOEILAMPENFABRIEKEN. Fr. 663,157, Oct. 29, 1928. Glass of slightly raised coefficient of dilation is obtained by mixing the finely ground components and pressing them into coherent blocks or bars. The extremity of a bar may afterwards be placed in a flame to fuse it thus eliminating the use of crucibles. (*C.A.*)

Modifying the appearance of glass objects. VEREINIGTE HOVERSWERDAER GLASFABRIKEN STRANGFELD & HANNEMANN A.-G. Ger. 484,093, March 2, 1928. Glass objects are caused to resemble porcelain or earthenware by coating with oil, applying colors, and baking. (*C.A.*)

Glass. GUSTAV KEPPELER. Ger. 484,594, June 16, 1926. A method of melting glass by powdering it and mixing it with powdered substances which melt readily, such as alkali salts (except the chlorides) is described. (*C.A.*)

Heavy Clay Products

Masonry research. EDITORIAL. *Bull. Amer. Ceram. Soc.*, **9** [2], 19–21 (1930).—Architects, contractors, and builders have an honest prejudice against ceramic products because (1) ceramic products have failed, (2) engineering data on assembled units are inadequate, (3) there has been but little effort to secure the interest of the architects and engineers of our universities in making studies on assembled wall and pier units, (4) catalogs of ceramic ware producers do not conform to the A.A.A. standard for size, (5) there has not been organized group coöperation with the building designers and contractors. The need for research to determine suitable qualities of ceramic products for masonry requirements of all sorts is urgent and after an establishment of standards through the coöperation of the producers, architects, and contractors, there should be a rigid adherence thereto. E.J.V.

To test back-up materials. ANON. *Brick Clay Rec.*, **76** [3], 188 (1930).—To obtain definite information on the behavior of back-up materials, such as common brick and structural tile used in wall construction, under the loads from beams and trusses, a number of full-size tests on pilasters are to be made. It is intended to simulate in these tests the loading produced by a steel floor beam spanning 30 feet, with a uniform loading to produce a maximum fiber stress of 18,000 pounds per square inch and a deflection of 1 in 360 or one inch in the beam length. This condition is to be obtained by a device made of plates, screws, and wedges which may be used to tip the loading plate to conform to the slope of the elastic line of the beams as the loading proceeds. These tests are being conducted at the O.S.U., Eng. Expt. Station. E.J.V.

Flat-arch construction. ANON. *Brick Clay Rec.*, **76** [3], 192 (1930).—Three car loads of clay tile in shapes required for so-called "flat-arch" construction of floors have been supplied for tests on flat-arch systems which are to provide information for formulas to be used by designers and builders. The tests are to be made by C. T. Morris and G. E. Large at the O.S.U., Eng. Expt. Station. The test slabs are being made just as in practical construction, spanning the space between steel I-beams with the arch of building tile used in conjunction with steel tie rods. E.J.V.

Researches on brick with magnesia efflorescences. ANON. *Le Ciment*, **34** [12], 602 (1929); *Tonind.-Ztg.*, **54** [3], 52 (1930).—The Union Technique du batiment et

des Travaux Publiques investigated brick showing magnesia efflorescences which had partially destroyed the vitrified skin of the brick. The reason for the efflorescence was that the brick contained magnesium sulphate, which according to the statement of brick producers was to be traced back to an error in manufacturing. Owing to the small quantities of soluble salts any effect on the properties of the brick was scarcely to be expected. Comparison tests gave the following results: (1) brick without efflorescence: resistance to pressure 155.5 kg./sq. cm. porosity 11.7%; (2) brick with efflorescence: resistance to pressure 181.8 kg./sq. cm., porosity 11.3%. Thus efflorescence increases the resistance to pressure. M.V.K.

Evaporation of water from brick. L. F. COOLING. *Brit. Clayworker*, **38** [453], 384–88 (1930).—The problem of efflorescence and decay in building materials is considered from a physical point of view. The movements of water taking place in brick during drying are studied in order to gain some knowledge of the way in which soluble salts migrate from one portion of a wall to another and to investigate the factors influencing the position at which crystallization occurs. Experiments on the drying of brick under controlled conditions are described and the mechanism by which drying takes place is discussed. It is shown that physical structure greatly influences the progress of drying. It is suggested that one of the important factors in determining the direction of transfer of water (or salt solution) between two different materials in contact is the "capillary head," which depends on pore size. A fine-pored material tends to draw water and salt solution from a coarser-pored material, and thereby influences the position at which crystallization occurs. A number of typical examples of efflorescence and allied phenomena are explained on this basis. R.A.H.

Water absorption and penetrability of brick. J. W. MCBURNEY. *Proc. A.S.T.M.*, **29**, 711–39 (1929); for abstract see *Ceram. Abs.*, **8** [10], 735 (1929). R.A.H.

Lighter brick. ANON. *Clay-Worker*, **93** [2], 135 (1930).—It is reported that a Berlin engineer, Arthur G. Winckel, has recently invented a brick only one-sixth the weight of ordinary brick, and that it can be made of any size and color and will thus help reduce the weight load in skyscraper construction. While the details of the process are not given, unless it is some kind of a new cinder concrete brick idea, the natural inference, in view of the research showing at the tile convention in Chicago last year, is that something of the same idea of acid-yeasting is being applied to the making of brick. It should be practical to develop lighter brick in this way as well as lighter tile for flooring and partition work in the tall skyscraper buildings, and it may be that this will mark the next important step in brickmaking. E.J.V.

Preparation of clays. FRITZ LIEBELT. *Tonind.-Ztg.*, **54** [1], 6–8 (1930).—Defects in brick which are frequently ascribed to improper firing and drying are more often the result of improper preparation of the clays. (1) L. describes the dry and wet processes for preparing clays. The dry process is recommended for slate clays. Moist clays should first be dried and ground before being moistened. The importance of efficient mixing machinery and stokers is emphasized. Clays or loams containing calcium carbonate and calcium sulphate can be improved by fine grinding and washing (2) He takes up the soaking and the fermenting processes for preparing clays for clinker, hollow brick, tile, or thin-walled ware. Warping and curving during firing may be reduced by adding large quantities of brick powder to the raw material during mixing. M.V.K.

Standardization of porous brick made from clays and gravel. R. K. W. *Nachrichten*, pp. 302–303 (1929); *Tonind.-Ztg.*, **54** [4], 67 (1930).—The technical commission of the Rhine pumice industry has drawn up a plan of standardization of porous brick made from clays and gravel under the following headings: general, resistance to pressure, form, specific gravity, resistance against frost, thermal conductivity, and

refractoriness. Porous brick made from clay and gravel are like those prepared from Rhenish volcanic pumice stone and hydraulic binding agents, except that no admixtures of quartz, sand, slag (blast-furnace slag), or tufa are included. Three kinds of porous brick are differentiated: (1) lime-clay-gravel brick, with hydraulic- or lime-containing dolomite as a binding agent; (2) cement-clay-gravel brick having cement and other hydraulic binding agents; (3) special cement-clay-gravel brick (for higher requirements) which have as binding agent either cement only or cement with a small amount of other hydraulic binding agents. Resistance to pressure in lime-clay-gravel brick must be at least 12 kg./sq. cm.; in cement-clay-gravel brick, at least 20 kg./sq. cm.; and in special cement-clay-gravel brick, at least 30 kg./sq. cm. The average of 10 tests establishes resistance to pressure. If these tests are not made, the brick cannot be sold as standardized brick. The regulation size of brick is the so-called 4-in. brick, 25 by 12 by 9.5 cm.; other usual measurements are 2.5-in. brick, 25 cm. by 12 cm. by 6.5 cm.; 3.5-in. brick, 25 cm. by 12 cm. by 7.5 cm.; 5.5-in. brick, 25 cm. by 14 cm. by 12 cm.; 7.5-in., 25 cm. by 16 cm. by 14 cm. Measurement deviation of 5% for the height and 2% for length and width are permitted at delivery. The specific gravity maximum for lime-clay-gravel brick is 0.75; for cement-clay-gravel brick 0.85, and for special cement-clay-gravel brick 0.85. The brick must not show noteworthy breaking at the prescribed frost tests. The thermal conductivity in air-dried clay-gravel brick must amount to 0.13 to 0.16 at a temperature difference of 20. The refractory properties are not given. M.V.K.

Insufficient firing of brick. ANON. *Tonind.-Ztg.*, **53** [99], 1740 (1929).—Insufficient firing of brick can very easily be detected not only by the color but by a characteristic dull sound of the brick, and the brick can be easily scratched with a knife Red brick show a pale red color with sometimes a yellowish cast; yellow brick are much paler and white brick may show a reddish or pink tint. Internal defects or impurities such as chalk particles, iron pyrite, or soluble salts may also be discovered as they frequently appear during drying. M.V.K.

Accumulation of clay in brick molding machines. R. KOLLER. *Tonind.-Ztg.*, **54** [3], 36–37 (1930).—The reasons for the clogging of brick molding machines with clay and ways of preventing this are explained. M.V.K.

Avoidance of faults due to moisture in brick constructions. ANON. *Rev. mat. constr. trav. pub.*, No. 243, pp. 263–64B (1929). A.J.M.

Darkening of tile. ANON. *Tonind.-Ztg.*, **53** [101], 1773 (1929).—The darkening of tile is not necessarily due to the iron, manganese, and vanadium which the tile may contain, but more probably to the porosity or surface roughness which permits the gradual deposition of mud, soot, dust, and the growth of algae. Smooth-surfaced tile having only the finest cracks and unevenness are eventually darkened in the same way although the process is much slower. It depends also on the chemical composition of different clays. M.V.K.

Clay products express modern architectural ideas. ANON. *Brick Clay Rec.*, **76** [3], 178–79 (1930).—Brickwork as designed by modern architects is taking on a new appearance. Special shapes are being employed and the modern interpretation of present day art is being expressed in the motif of the building itself. Brick is being used for decorative effects and in flowing colors. Pictures of new structures erected along modern architectural ideas are presented. E.J.V.

Colors in face brick. ANON. *Brick Clay Rec.*, **76** [2], 102 (1930).—Gold, silver, bronze, metallic greens and blues in the brightest shades are being manufactured by the Continental Clay Products Co., Pittsburgh, Pa. It is reported that this company has secured the American rights to a German patent which is enabling them to produce what are without question the most startling colors that have ever been put on face

brick in this country. In viewing these new colors the particular quality which arrests the attention is their beautiful brilliancy and their distinct metallic sheen. It is understood that real metals are deposited on the surface of the brick at high temperatures through a special patented process and that they can be applied equally well on smooth or rough texture brick. There are many possibilities opened up through these new face brick. E.J.V.

Metal-coated brick in startling colors. ANON. *Brick Clay Rec.*, **76** [3], 194 (1930).—A new development of the Alliance (Ohio) Clay Products Co. is a metal-coated brick. The brick are of standard size and various face textures. They are fired in the regular manner, after which by an electric process, a coating of metallic substance is applied to the face of the brick. Brick are made in copper, bronze, verde copper, and nickel finish, and are designed primarily for interior use, especially adaptable to modernistic types of architectural treatment. E.J.V.

Vincent Clay Products Co. ANON. *Brick Clay Rec.*, **76** [3], 180–88 (1930).—An illustrated description of the Vincent Clay Products Co. plant of Fort Dodge, Iowa, is presented. An 18-chamber continuous kiln is busy firing brick, drain tile, or hollow building tile; a shale planer, two stiff-mud machines, and other features are used. There have been no long shut-downs since the building of the plant in 1913. E.J.V.

High industrial fire loss. ANON. *Commercial Stand. Monthly*, **6** [7], 207–208 (1930).—Fire losses affect natural and created resources of the nation. Industrial fires occur usually in larger buildings, and it is found that design, and exterior and interior appointments of the building are important. In making fire-resistance tests on materials a furnace fire test was used. Many interesting facts were discovered in connection with fire-resistance tests made on various types of materials, including all sorts of masonry construction, hollow tile, brick, and plaster. Some of the details of tests and methods are given. E.J.V.

Hollow building tile. ANON. *Commercial Stand. Monthly*, **6** [7], 208 (1930).—A survey of hollow building tile production for 1928 shows 89.54% adherence to Simplified Practice Recommendation, developed by the industry in 1924. E.J.V.

Simplified practice in paving brick industry. STANLEY A. KNISELY. *Commercial Stand. Monthly*, **6** [7], 203–204 (1930).—A tabulation of the different sizes and styles of paving brick made and shipped between 1914 and 1920 revealed that there were 66 different kinds being manufactured. At the first conference, in 1921, these were reduced to 21, and each subsequent year further elimination reduced the number until now there are five recognized sizes and styles of vitrified paving brick. Beneficial results are listed. E.J.V.

Glazed sewer-pipe manufacture. ANON. *Brick Clay Rec.*, **76** [2], 138 (1930).—After several years of experimentation the A. S. Hasle Klinker and Chamottestenfabrik, Copenhagen, claims to have succeeded in producing a glazed sewer pipe which it says is fully able to compete with the products of foreign manufacturers who in the past have supplied the entire Danish demand. The plant is located on the island of Bornholm and until recently has been occupied with the manufacture of fireproof building materials, roofing and wall tiles, etc. E.J.V.

Brookhaven Pressed Brick & Mfg. Co. ANON. *Brick Clay Rec.*, **76** [2], 105–12 (1930).—The plant, located at Brookhaven, Miss., is completely electrified, a total of 175 H.P. being connected to the various machines. Brick coming out of the tunnel kiln are of a quality that permits their use either as face brick or common, depending only on the needs and desires of the purchaser. The dry-press process used makes a smooth, mechanically excellent brick and a variety of colors are produced ranging through many shades of red and brown in both clear and flashed surfaces. A detailed description of the plant equipment and methods is given. E.J.V.

Constructive criticism of face brick industry. GEORGE P. ANDERSON. *Clay-Worker*, **93** [2], 114–15 (1930); see also *Ceram. Abs.*, **9** [3], 187 (1930). E.J.V.

Report of Committee C-3. ANON. *Proc. A.S.T.M.*, **29** [I], 271–73(1929).—A complete revision of Sections 1 to 15 of the tentative specifications for paving brick (C7–28T) has been prepared by Sub-Committee IV on paving brick, and it is recommended that these revisions be accepted for publication as tentative in place of the present tentative ones. Changes are also made in Sections 26 and 28. R.A.H.

BOOK

Ten Years of Stoneware. FELIX SINGER. Extract from book Ten Years of German Ceramics, 1919–1929, published by Keram. Rundschau. During and subsequent to the World War the sewer-pipe industry suffered a severe depression resulting in 1922 in the formation of a united sales organization embodying 96% of the manufacturers and having as its object standardization and lowering of manufacture and sales costs through balancing production and saving in freight rates. A chart showing imports and exports prior and subsequent to the World War show the former as almost negligible and the latter increasing from 10,000 T. in 1913 to 40,000 T. in 1927. The chemical stoneware industry, the capacity of which was doubled during the War, has subsequently lost most of its large European export trade and is endeavoring to find new markets by concentrating on quality production. Two charts comparing earnings of skilled and unskilled labor show that the wages of employees in this line are considerably above those in other standard lines making the introduction of improved machines, methods, and fuel economy imperative. Two tables listing physical properties and showing the improvements achieved since 1905 are given. F.A.W.

PATENTS

Building block and method of laying same. EDWARD M. LANE. U. S. 1,744,171, Jan. 21, 1930. A building block comprising a base portion in the form of an open rectangular framework of substantially square cross section, and of a length equal to twice its width, and an upper portion having side members of similar cross section but of one-half the length symmetrically superposed upon the middle of the base.

Producing sand-lime brick. HARRY WILLIAMS CHARLTON. U. S. 1,745,601, Feb. 4, 1930. A method of manufacturing sand-lime brick which comprises subjecting it to steam pressure in a hardening cylinder till the brick have attained the required strength; blowing off a portion of the steam; adding sufficient aqueous solution to condense the steam remaining in the hardening cylinder; drawing off the liquid and removing the brick from the cylinder to cool and dry.

Brick-setting machine. HOLLIS B. CRUM. U. S. 1,745,743, Feb. 4, 1930. In a brick-setting machine, the combination of a plurality of lifting fingers, a brick-gripping device mounted on each of the fingers, each gripping device operable to engage with one face of the brick and grip the same and force the brick into engagement with the adjacent finger, hydraulic means for operating the gripping devices simultaneously and means for operating the hydraulic means to apply pressure to the gripping devices proportional to the weight of brick on the fingers.

Brick edger. GRAFTON E. LUCE. U. S. 1,746,664, Feb. 11, 1930. In combination a platform adapted to receive a plurality of brick and discharge the same in predetermined relation, the platform having a plurality of apertures arranged in predetermined relation, and a striking member adapted to strike the upper surfaces of the brick for causing them to tumble through their respective apertures and be turned onto their side edges by means thereof.

Drain-tile band. GLENN F. BUTLER. U. S. 1,747,500, Feb. 18, 1930. A device for holding the adjacent ends of drain tile in alignment comprising a flexible band formed

from sheet metal adapted to overlap the joint, the band being formed to provide drain passages between the same and the tile extending angularly with respect to the length of the band.

Drain-tile band. GLENN F. BUTLER AND CHARLES L. HAMAN. U. S. 1,747,501, Feb. 18, 1930. A device for securing adjacent ends of drain tile in alignment comprising a flexible band split transversely of its length and adapted to be bent around the ends, the surface of the band adapted to contact with the tile, being provided with means artificially applied thereto permitting the drainage of water between the band and the tile.

Ornamenting brick. CAFFERATA & CO., LTD., AND B. J. CAFFERATA. Brit. 321,593, Dec. 31, 1929. Clay or marl brick are dipped in acid in the green state to etch or weather the surface. Thus the dried molded brick may be dipped in sulphuric, hydrochloric, or nitric acid, then washed and finally fired in the usual way.

Refractories

Refractory clays of Ohio. WILBER STOUT. *Bull. Amer. Ceram. Soc.*, 9 [2], 29–37 (1930).—After a brief historical sketch of the manufacture of fire brick in Ohio, the present active firebrick plants in Ohio are enumerated and their distribution noted. The distribution of the clay-bearing rocks is discussed. In general, the clays of value are confined to the Pottsville and Allegheny series, or to the lower half of the Pennsylvanian system. The only important members bearing flint and plastic clays of high heat-resisting qualities are the Sciotoville, Clarion, Lower Kittaning, and Oak Hill members, which are discussed in greater detail individually. E.J.V.

Fire clays of Pennsylvania. HENRY LEIGHTON. *Bull. Amer. Ceram. Soc.*, 9 [2], 22–26 (1930).—The fireclay deposits of Pennsylvania are confined to that part of the state north, northwest, or west of a line drawn from Williamsport, through Tyrone and Altoona, and south to Meyersdale, in the physiographic province known as the Allegheny Plateau. Of the series of bedded deposits making up the Allegheny Plateau, the Permian and Mississipian and older strata contain no fire clays of value, but the Pennsylvanian series does, especially in the Allegheny series. An approximate section of the Allegheny series is given and the members thereof and their characteristics are discussed in some detail. Drawbacks to the development of the flint clays in Pennsylvania have been (1) isolated mountain-top position of many of the deposits necessitating long tram roads or expensive inclines; (2) great variations in thickness and character of the bed, demanding careful prospecting and closely-spaced drill holes; and (3) the general tendency for the flint clays to run into high iron or high silica types. E.J.V.

Properties of refractories and their relation to conditions in service. STUART M. PHELPS. *Trans. Amer. Soc. Mech. Eng.*, **50** [8], 52–58 (1928).—Furnace operations have, in recent years, demanded more from refractory linings. Pronounced advancement in the development of the usual refractories cannot be expected. Materials such as silicon carbide, fused alumina, and the sillimanite minerals or mullite have been utilized but their necessarily high cost when calculated into production per unit of refractory often limits their use. Conditions encountered in boiler settings are given. Invariably all types of refractories possess ample rigidity for any constructional requirement. Data given show the typical cold strength of various refractory materials. The control of sizes, the degree of fineness of materials, and the forming process can be regulated by the manufacturer. Firing is of major importance since variation in strength may be produced by varying the time and temperature of the kiln firing. Rigidity of a given refractory structure is affected by thickness of the joints and re-

fractoriness of the cement. The cooler the outside surface of the wall, the longer it will withstand the agencies that tend to destroy it within. Resistance of the refractories to abrasion, and hardness cannot be altered greatly, except possibly through hard firing. The P.C.E. is one of the most commonly used tests for refractory materials, but like most other tests, it is of value primarily as a control test for raw materials and as being indicative of other properties of the brick. Data thus obtained can seldom be employed directly to conditions in service. Slagging and spalling are the two major causes of refractory failures. Slagging primarily is chemical and is greatly influenced by many physical factors. The reactions take place by contact and if restricted to the brick surface will be at a minimum. Low porosity is, therefore, desirable, consistent with other properties required by service. The state of oxidation of the furnace atmosphere is an important factor in slagging where iron is present. A reducing atmosphere reduces the iron compounds, which form silicates that have a much lower melting point than the oxidized compounds. The general heading of spalling has three subdivisions. Each of the subdivisions, mechanical, structural, and thermal, deals with distinct causes of spalling, and yet in service it is often difficult to distinguish or identify. Clay refractories are, as a class, very resistant to spalling. In service it is difficult to spall them thermally. The most significant advancement in refractories problems will result in the intelligent application of specific types of refractories in a manner that shall supply the utmost in the properties required for a given service. E.P.R.

Report of Committee C-8 on refractories. L. J. TROSTEL. *Proc. A.S.T.M.*, **29** [I], 282–87 (1929).—The sub-committee on Industrial Survey gave its report on the 65 questionnaires which had been submitted to power plant men with reference to the determination of the service conditions surrounding the use of high-temperature cements and other jointing materials. Certain conclusions were drawn on "nomenclature," "refractoriness," "tightness of joints," "workability and ability to stay in suspensions," "air setting," and "ability to carry loads." In connection with the "service spalling test," a new type of furnace has been completed and experimental work conducted to determine the best procedure to classify various types of brick. The present furnace will measure resistance to a variety of factors causing spalling, whereas the present tentative test measures only resistance to thermal action. Brief reports are also given with reference to the reheating test, abrasion at high temperature, precision and tolerance, heat transmission, slagging test, and temperature. R.A.H.

Refractories research committee organized. ANON. *Amer. Glass Rev.*, **49** [16], 14 (1930).—Organization of a special research committee to aid in the solution of problems affecting refractories was announced recently by the Refractories Division of the AMERICAN CERAMIC SOCIETY. E.P.R.

Research work in refractories industry. S. R. HIND. *Refrac. Jour.*, **5** [52], 134–41 (1930).—There are many different classes of materials used to withstand conditions inside furnaces. The definition of these materials is primarily chemical, but without close control of physical factors such as grain size and shape, porosity, and heat treatment, it would be impossible to maintain satisfactory or uniform quality. Where sufficiently accurate records do not exist in the literature, the first aim must be to obtain expert personal knowledge of every aspect of manufacture and use. Accurate descriptions, with all necessary data, must be accumulated and presented in a scientific manner. It is important that such primary data should be freely available to other workers. In connection with the use of refractory materials investigations center chiefly around the following tests: (1) rigidity or strength, cold and hot; refractoriness, or ability to withstand temperature, with and without load; (2) analysis, chemical, physical, and mineralogical; (3) porosity, density, after-contraction or expansion, per-

meability; (4) specific heat, thermal expansion (reversible), thermal conductivity, and elasticity at various temperatures; (5) simulative tests of various kinds, among which may be mentioned empirical tests for abrasion, slagging, and spalling. The use of these tests is of the greatest assistance in maintaining uniform products and leads the investigator and user to combine in making specifications which form a concrete basis for steady improvement. E.P.R.

Value of scientific research on refractory materials. F. WEST. *Refrac. Jour.*, **5** [52], 131–32 (1930).—Research today is not the production of petty graphs, it is a practical scientific process which no progressive firm can afford to ignore. The increased demands for refractory materials during the War, particularly in the manufacture of steel and glass have shown the need of further scientific investigation. The assistance of the scientists is essential in determining the composition and the chemical, physical, and other properties of such substances, having in view the purpose to which they will be applied. It is also necessary to explore systematically the failures of refractories in use so as to get a better understanding of the conditions which are favorable or inimical to a long life. This work is not confined to known refractories but is extended to the discovery and utilization of new combinations of refractories, produced by new methods of manufacture, to cope with the growing demands of the users of refractories in many industries. E.P.R.

Research in technology of refractory materials. A. T. GREEN. *Refrac. Jour.*, **5** [52], 133–34 (1930).—The technology of clay and silica products has progressed considerably during the past decade. Much of this progress in the laboratory and fundamental data of the importance to industrial usage of these products have been realized. Further research into the problems concerning the manufacture and industrial usage of refractories is imperative. Together with investigations of fundamental properties, the definition of the actual conditions obtained in the use of refractory products is essential. This phase of the work has not received much attention. Many apparently superior products have failed in specific duties, whereas the so-called inferior material has given comparative success in the same field of utility. This emphasizes the need for the adequate definition of working conditions. Endeavors to overcome this state of affairs must be made if the refractories industry is to meet its demands more accurately. G. discusses refractories research in relation to the iron and steel and carbonizing industries. E.P.R.

British Refractories Research Association. ANON. *Refrac. Jour.*, **5** [52], 150–52 (1930).—Experiments on frothed clay arose from the great economic importance of thermal insulating material in construction of kilns, ovens, and furnaces. Kieselguhr, the most effective material at present, becomes unsatisfactory at temperatures in excess of 900°C. Since the structure of the material was the principal factor in insulation, an attempt was made to impart a finely porous structure to plastic refractory clay. Some success was achieved by frothing clay slip, drying, and firing the product, using it as a grog in forming articles. These display excellent qualities in respect to strength and permanence. Experimental work on highly grogged fire brick indicates that better mechanical properties and increased durability may be obtained from brick made mainly from grog as compared with brick made from the same raw material with only small proportions of pre-fired clay. Deflocculated clay slip is preferable as a bond because it allows the clay to spread more quickly over the grog than does ordinary slip. E.P.R.

Refractory brick and its manufacture. H. E. TOWNSEND. *Blast Fur. Steel Plant*, **18** [1], 105 (1930).—Presented in simple form, free from statistical data and technical discussion, these notes are intended to interest operating men in the methods by which fire brick are made. In the U.S., the fireclay beds of New Jersey are probably the

first to have been discovered and it is said the first fire brick were made in this country in 1812. F.P.H.

Refractories. I. R. M. DOIDGE. *Blast Fur. Steel Plant*, **17** [12], 1854–58 (1929).—Some of the chief causes which determine the life of refractories, or cause premature failures are as follows: (1) lack of refractoriness, (2) shrinkage or expansion in use, (3) softening under load, (4) mechanical erosion or breakage, (5) cracking or spalling, and (6) erosion by slags or fluxes. These factors are considered in detail. F.P.H.

Mortar for constructing ovens. P. B. ROLINSON. *Gas Age-Rec.*, **65** [1], 5 (1930).—A mortar for use in building the masonry of coke ovens which consists of fire-resistant brick is obtained by mixing 50% of clay, 25% of chamotte, and the same quantity of sand. In those coke ovens where there is no danger of clinkering of the mortar and which can be repaired from time to time without any great trouble, the mortar may be made from a mixture of clay and chamotte. A mortar that can be used in building coke ovens with silica brick consists of a mixture of 10% plastic clay, 30% of chamotte, and 60% of ganister. On the other hand, this mortar is not suitable for use in the gas works and it has been found better to use a mixture of finely ground ganister with approximately 5% lime. F.P.H.

Setterberg's methods for making refractory insulating materials. ANON. *Feuerfest*, **5** [11], 195 (1929).—Refractory materials are made highly porous by the addition of substances which evolve gas before firing. Thereby the weight of the material may be decreased by one-half and the insulating properties greatly increased. L.T.B.

Refractory formers for electric heating elements. P. COOPER. *Trans. Ceram. Soc.* [Eng.], **28** [7], 333–37 (1929).—The chief qualities of a first-class refractory former for electric heating are (1) good thermal strength, (2) reasonable mechanical strength, (3) sufficient electrical resistance at maximum running temperatures, (4) negligible variation in size, (5) material such as will enable production to be carried out easily and cheaply, and in some cases, (6) color according to demand. It is desirable that the materials and mixtures used should have in service a low coefficient of expansion, particularly as, owing to design, many articles are very fragile. The mechanical strength is important so that the made article will stand up to reasonable treatment while being handled, not only in the factory but in the assembling with metal work. For refractory elements of the types under discussion the voltage used is not high, the pressure is quite sufficient to cause serious leakage of current and short circuiting if the refractory is not a reasonably good electrical insulator at the maximum temperature employed. The low resistance sometimes experienced may be brought about by another factor, the occurrence of a green coating on the refractory. This green deposit has given serious trouble and its cause has been the subject of considerable investigation. The presence of some alkalis (sodium in particular) in or on the refractory is extremely detrimental to the nickel chrome wire used in the element. From the samples discussed, it will be seen that all refractory formers cannot be made from one formula. The necessity of almost continual adjustment or mixture of bodies is due to variation in design, size, electrical loading, color, and different processes of manufacture. The results of many tests have shown that to produce satisfactory articles the same care must be exercised and the same precautions taken with the materials as when making the highest-class ceramic porcelains. R.F.S.

Comparative action of glass, soda, and sulphates on fireclay brick. P. P. BUDNIKOFF. *Feuerfest*, **5** [11], 181–83 (1929).—A fireclay pot must not only give a long life but the glass produced in it must be of good quality. Poor fire clay very often causes stones in glass. To determine the quality of fire clay, blocks of it were provided with depressions in which various materials (glass, soda, etc.) were placed and heated to

1430°C for two hours. Examination showed that the sulphates were the most corrosive especially in the presence of carbon (coal). Soda was next in order. A glass raw mixture was more destructive than glass itself. The corrosive action depends on the porosity which for a glass pot should not exceed 28%. L.T.B.

Cupola refractories. COLIN PRESSWOOD. *Refrac. Jour.*, **5** [51], 98–104 (1929); for abstract see *Ceram. Abs.*, **9** [3], 200 (1930). E.P.R.

Gas-heated furnaces. WALTER. *Refrac. Jour.*, **5** [50], 68 (1929).—Design and operation of gas-heated furnaces are outlined together with a discussion of thermal efficiency, regeneration, recuperation, heat balances, and automatic furnaces. Using silicon carbide as combustion chamber refractory, a thermal conductivity 8 to 10 times as great as that of ordinary firebrick work has been attained. E.P.R.

Cement kiln refractory linings. K. ENDELL. *Zement*, **18**, 38 (1929); *Rock Prod.*, **32** [26], 96 (1929).—E. reports on the heat expansion and sensitivity to temperature of refractories used in wet-process rotary kilns. He describes the Steger heat expansion recorder for temperatures up to 1652°F and a new "comparative apparatus" for temperatures to 2912°F. Expansion curves are given for acid chamotte stone, basic chamotte brick, high-alumina chamotte brick, well-fired silica brick, poorly-fired silica brick, magnesite brick, and cement clinker brick. E. also describes an electrically-operated device and its use for determining the resistance of refractories to sudden temperature changes. The number of "freezings" resisted by the refractories quenched in cold water from 1652°F were; acid chamotte brick, 3 to 5; basic chamotte brick, 5 to 30; silica brick, magnesite brick, and cement clinker brick, 1 to 2. W.W.M.

Practical testing of kiln brick. ANON. *Rev. mat. constr. trav. pub.*, No. 243, pp. 261–62B (1929). A.J.M.

Mechanical tests on refractory products at high temperatures. E. L. DUPUY. *Le Ciment*, **34** [10], 486–88 (1929); *Tonind.-Ztg.*, **54** [1], 17 (1930); for abstract see *Ceram. Abs.*, **9** [2], 122 (1930). M.V.K.

Exhibit of furnace linings at the Berlin Glass Exhibition in 1929. ANON. *Glashütte*, **59** [50], 913–14 (1929). L.T.B.

Refractory linings. (A. Ya. Fogel, inventor). B. N. DOMONTOVICH. *Izvestiya Teplotekhnicheskago Instituta [Russia]*; *Trans. Thermo-Tech. Inst.*, **6**, 88–91 (1929).—Linings for steam-boiler fire boxes were prepared from used refractory material, fire clay, and crushed stone mixed with water. The fire boxes pasted with this mixture were first dried and then slowly heated. Small fire boxes were pasted directly, while large units were lined with sheet iron and had air jackets. Practical tests on boilers of various systems showed this lining to be far superior to the usual refractory material; the life averaged 30 to 40% longer. (*C.A.*)

Blast-furnace lining and relining A. COUSEN. *Blast Fur. Steel Plant*, **17** [12], 1823–24 (1929).—Methods of blowing out and relining that have reduced the period of interrupted production are described. F.P.H.

Softening temperature of fire brick under load. S. KONDO. *Chem. Abs.*, **23** [17], 4311 (1929); *Refrac. Jour.*, **5** [51], 128 (1929); for abstract see *Ceram. Abs.*, **8** [9], 658 (1929). E.P.R.

Loftus checker brick in open hearth. ANON. *Blast Fur. Steel Plant*, **17** [12], 1853–54 (1929).—After having experimented with many types of refractories, Loftus brick is being used in the checker work of four of the eight basic open-hearth furnaces operated by the Andrews Steel Co., producers of straight carbon and alloy steels. The considerably longer life and the possibility of shorter heats in this type of checker work are responsible for a saving of $0.188 per T. of steel produced. F.P.H.

Notes on sorting, classification, and briqueting of chrome and manganese ores. R. K. KRISHNASWAMI. *Jour. Indian Inst. Sci.*, **10** [A], 65–70 (1927).—The grade of

chrome ore can be ascertained with some exactness when broken by its fracture. Specific gravity is not a reliable indication of the quality of chrome and manganese ores. Several types of low-grade ores were concentrated on Wifley Table. The loss of chrome ores during concentration was very small. As it has not been found practicable to ship powdered ores in bulk, briquets were made of concentrates using 1.5% of a 35% Na_2SiO_3 solution. Briquets thus bonded when heated to 200°C had enough strength to withstand rough handling. A.A.

Influence of aluminum on properties of slags in steel-melting furnaces. GEORG MARS. *Stahl Eisen*, **49** [37], 1339–40 (1929); *Tonind.-Ztg.*, **53** [99], 1748 (1929). M.V.K.

Minerals containing aluminum oxide and silicic acid in glass pots and tank blocks. W. J. REES. *Jour. Soc. Glass Tech.*, **9**, 32–36 (1925); *Tonind.-Ztg.*, **53** [102–103], 1804 (1929).—Discussion led by W. E. S. Turner, E. A. Coad-Pryor, G. V. Evers, H. G. Cameron, F. W. Hodkin, and W. C. Snowdon which was replied to by W. J. Rees. See also *Ceram. Abs.*, **4** [3], 64 (1925). M.V.K.

U. S. imports of bauxite from Surinam. ANON. *Mining Jour.*, **162** [4853], 737 (1928).—American production of bauxite does not meet its demands. Imports changed from 119,020 T. in 1923 to 350,850 T. in 1927. Imported chiefly from British and Dutch Guiana (Surinam). E.C.C.

Hungarian bauxite industry. ANON. *Mining Jour.*, **163** [4868], 1023 (1928). E.C.C.

Flotation of low-grade bauxites of South-Eastern states. ANON. *Mining Jour.*, **164** [4881], 195 (1929).—Preliminary tests made on the low-grade high-silica bauxites of the South-Eastern states at the Southern Experiment Station of the U. S. Bureau of Mines in coöperation with the Univ. of Ala., have demonstrated that certain classes of these ores may be treated by the flotation process with fair results. In some cases, the impurities were of such minute dissemination that physical processes of separation were impossible. Sodium sulphide and oleic acid were used as flotation reagents. E.C.C.

Bauxite occurrences in Jugoslavia. ANON. *Mining Jour.*, **162** [4857], 789 (1928).—Bauxite deposits lying along the shore of the Adriatic Sea are rich in Al_2O_3, but are in part siliceous. In 1915 when production commenced, 79,032 T. were produced. E.C.C.

U. S. graphite trade; first half 1928. ANON. *Mining Jour.*, **163** [4861], 869 (1928).—A recent U. S. commerce report reviews the graphite industry during the first half of the year. The U. S. is dependent to a large extent on foreign sources. Domestic production in U. S. in 1927 was 5200 short T. while 17,400 short T. were imported. For the first six months of 1928 the imports were, amorphous graphite 4898 T., crystalline lump graphite 6058 T., and flake graphite 1121 T. Mexico is the chief producer of amorphous, Ceylon of crystalline lump, and Madagascar of flake graphite. E.C.C.

Opposition to new duties on graphite. ANON. *Iron Age*, **124** [27], 1739 (1929).—American importers, grinders, and crucible manufacturers say that additional duties on importations are needlessly burdensome because local graphite is unsuitable. E.C.C.

Ceylon graphite in 1928. STAFF CORRESPONDENT. *Mining Jour.*, **164** [4883], 222 (1929).—The actual exports of graphite for 1928 were 14,346 T. at a value of Rs. 188.51 per T. as compared with 1927 exports of 12,906 T. at Rs. 196.00 per T. The demands were chiefly for carbon lump plumbago, chips, dust, and flying dust with little demand for high-grade crucible plumbago. E.C.C.

Scorification of magnesite. R. MIKSH AND H. SALMANG. *Stahl Eisen*, No. 48

(1929); *Tonind.-Ztg.*, **54** [1], 17 (1930).—In experiments made by the authors, slag showed a greater corrosive action on crucibles made of grog than on those made of magnesite. Basic oxides did not affect magnesite, and, of the acids, only phosphoric and boric affected it. During melting, the same materials, as well as silicic acid and aluminum in small proportions, were effective. In judging different magnesites it is important to know that magnesite poor in flux ingredients (4.48% Fe_3O_3) in spite of a higher porosity scorifies considerably less than one rich in flux ingredients (8.36% Fe_2O_3). At high temperatures magnesium seems to lose its property as a base and adopts an amphoteric character. M.V.K.

Russian magnesite. ANON. *Tonind.-Ztg.*, **54** [1], 11–12 (1930).—The magnesite of Russia, because of its small iron content, and its high sintering and refractory properties is being increasingly imported from Russia by Germany in the form of (1) sintering magnesite in granules of 0 to 15 mm., (2) magnesite blocks, (3) caustic magnesite, and (4) raw magnesite. M.V.K.

Electrical conductivity of magnesites and other refractory materials in relation to temperature. E. DIEPSCHLAG AND F. WULFESTIEG. *Tonind.-Ztg.*, **54** [1], 17 (1930); see also *Ceram. Abs.*, **9** [2], 108 (1930). M.V.K.

Silica refractories. KNOX. *Iron Coal Trades Rev.*, **12** [27], 985 (1929); *Refrac. Jour.*, **5** [52], 160 (1930).—Reference is made to the microscopic tests on refractories in order to insure the proper conversion of the quartz into tridymite and cristobalite, together with other tests such as fusibility with and without load, porosity, and expansion. K. deals with tests on finished refractories and the evaluation of tests. E.P.R.

Minerals in silica brick. ANON. *Brit. Clayworker*, **38** [453], 374 (1930).—Many users and some manufacturers of silica brick suppose that brick containing 96% of silica cannot contain an appreciable proportion of other minerals. This is a mistake since some of the silica is associated with lime, etc., and the minerals are present in much larger proportion than the difference between 100 and the percentage of silica. The behavior of mixtures of lime and silica is shown in an accompanying chart. In silica brick no free lime is present. R. Ruckert has shown in recent investigations the forms in which the subsidiary minerals occur. In a silica brick containing silica 96.00, lime 1.75, magnesia 0.16, iron oxide 0.67, and alumina 1.41%, the mineral composition is likely to correspond to quartz and tridymite 94.96%, gehlenite and equivalents 3.81%, monticellite and equivalents 0.54%, iron oxide (red) 0.67%. Both the gehlenite and monticellite minerals may be in the form of glass. R.A.H.

Abrasion test for silica brick. SANDFORD S. COLE. *Proc. A.S.T.M.*, **29** [I], 288–89 (1929).—A method for determining the resistance of silica brick to abrasion has been developed by the Koppers Co. Laboratories, Mellon Institute, which is a modification of the rattler test for paving brick. The test is performed on 10 brick in the manner and with the equipment described in the Standard Specifications for Paving Brick, except that the cylinder is rotated only 20 minutes or 600 revolutions. The resistance of silica brick to abrasion is indicated by the percentage loss in weight and will vary to a certain degree with the porosity, crushing strength, and modulus of rupture. This test for silica brick has been found to check quite closely with service data. A graph is given showing a comparison of the data obtained. R.A.H.

Experiments for production of sillimanite for manufacture of glass. W. A. MCINTYRE. *Jour. Soc. Glass Tech.*, 73–80 (1929); *Tonind.-Ztg.*, **53** [100], 1762 (1929).—Masses of natural sillimanite and ball clay were weathered for 6 weeks and by improving their consistency in this way it was assumed that at close contact with clay the sillimanite grains act as crystal grains and, with the formation of mullite, a solid binding is obtained. At temperatures of 1300°C and 1400°C an increase in the rate of

crystallization was observed. The resistance of the fired mass was tested, pieces of pyramidal form being heated in varying quantities of glass mixture. A mass containing 93% sillimanite was found to be most resistant. M.V.K.

Use of sillimanite in the glass industry. W. E. S. TURNER. *Glastech. Ber.*, No. 232 (1927–28); *Tonind.-Ztg.*, **53** [102–103], 1804 (1929); for abstracts see *Ceram. Abs.*, **5** [8], 253 (1926); **6** [10], 447 (1927). M.V.K.

Structure of sillimanite and mullite. W. H. TAYLOR. Reviewed in *Glastech. Ber.*, **6** [11], 666–67 (1929); *Tonind.-Ztg.*, **53** [104], 1821 (1929); for abstract see *Ceram. Abs.*, **8** [3], 200 (1929). M.V.K.

Sillimanite as refractory material for glass industry. A. COUSEN, W. E. S. TURNER, AND S. ENGLISH. *Glastech. Ber.*, p. 486 (1925–26); *Tonind.-Ztg.*, **53** [102–103], 1804 (1929); for abstract see *Ceram. Abs.*, **5** [5], 155 (1926). M.V.K.

New refractory "sillimanite." E. F. FERRARI. *Rass. min. met. ital.*, **69**, 103 (1929).—A general review of its properties. (*C.A.*)

Fire brick in the Middle West. ANON. *Brick Clay Rec.*, **76** [2], 103 (1930).—Considerable interest has been aroused in the refractories industry in the invasion into the Missouri fields by the large eastern manufacturers. In the last few years the Harbison-Walker Refractories Co. acquired the Walsh Fire Clay Co. of St. Louis and Vandalia, Mo.; the North American Refractories Co. took over the Farber Fire Brick Co., at Farber, Mo., and the latest move has been the acquisition of the Evens & Howard Fire Brick Co. properties by the General Refractories Co. Significant in connection with this movement of eastern interests into Missouri is the development of the steel industry in the Chicago territory. There is also a possibility of a migration of refractories capital to the South which may be accelerated by the entry of the General Refractories Co. into the Georgia field through the acquisition of the Stevens Pottery plant of Evens & Howard Fire Brick Co. E.J.V.

Trade marks in the refractory industry. ANON. *Feuerfest*, **5** [11], 185–87 (1929).—A list of trade names of refractory materials with the names and addresses of the manufacturers is given. L.T.B.

Economic position of refractory industries in Hungary. CARL H. PETERS. *Feuerfest*, **5** [11], 189 (1929).—Export and import figures for various industries are quoted. L.T.B.

Economic position of refractory industry in India. ANON. *Feuerfest*, **5** [11], 189 (1929).—Most refractories are imported, mainly from Japan. L.T.B.

Five-year program of the refractory industries of Russia. CARL H. PETERS. *Feuerfest*, **5** [11], 188 (1929).—The refractory industries are divided into five regional groups. The production today of comparable groups of plants is double that of pre-war days. There is, however, a shortage of fuel. Many new plants are planned for the next five years but lack of foreign credit and disturbed internal conditions may not see their completion. L.T.B.

BOOK

Modern Refractory Practice. HARBISON-WALKER REFRACTORIES CO. *Amer. Glass Rev.*, **49** [19], 14 (1930).—Divisional headings include fireclay refractories, high-alumina refractories, silica refractories, magnesite refractories, and many others. Application of refractories in various industries is described with one section devoted to glass. Tables and formulas are given. Illustrated. E.P.R.

PATENTS

Furnace wall. DAVID S. JACOBUS. U. S. 1,744,165, Jan. 21, 1930. A wall having bonding tile laid up in pairs in contact with each other as headers, each of the adjacent vertical side faces of each pair of tile having a relatively deep recess therein and a rela-

tively shallow recess extending from the deep recess to the outer end of the tile, the faces of the tile opposite the adjacent faces being unrecessed.

Manufacture of refractory acid resisting and other products bonded by means of clay. HUGO ACKERMANN, WILHELM LANGENHEIM, AND HERMANN KNUTH. U. S. 1,744,351, Jan. 21, 1930. The process of making ceramic products bonded by means of clay, consisting in liquefying the binding clay in any known way by admixing a sufficient quantity of water and a suitable quantity of liquefying ingredients, *e.g.*, alkali, admixing the clay slip thus obtained to the ground grog, or corundum, or quartzite, or zirconium, or any other nonplastic material fit to be bonded by means of clay, in such a proportion that a noncastable mass is obtained which is molded by beating, stamping, pressing or in any similar way likely to secure close contact between the adjoining grains of the mass, after which the molded products are dried and fired.

Refractory material. ALEXANDER HASSELBACH. U. S. 1,744,547, Jan. 21, 1930. Method of producing the highly refractory material which includes mixing corundum and a highly aluminous cement, and heating to a temperature above the fusing point of the cement.

Refractories. BERRY MARVEL O'HARRA AND EDGAR A. SLAGLE. U. S. 1,747,905, Feb. 18, 1930. Process of manufacturing magnesite brick which consists in crushing calcined magnesite into small particles, mixing with the particles water containing magnesium chloride in amount equivalent to 5 to 10% of the calcined magnesite, adding to the mixture an aqueous solution of sodium carbonate or ammonium carbonate in amount approximately equivalent to the magnesium chloride, thereby to form magnesium carbonate in contact with the particles of magnesite, compressing the mixture into blocks, firing the brick, whereby the magnesium carbonate is converted to magnesium oxide, and continuing the firing at a higher temperature to convert the magnesium oxide into periclase.

Refractory compositions. G. C. MARKS. Brit. 322,361, Jan. 22, 1930. A refractory body is made by melting, *e.g.*, in an electric arc, a mixture of alumina, clay, and a lithium compound, and cooling rapidly to reduce the size of crystals, the proportion of alumina to silica being preferably greater than that in mullite. An example of proportions is alumina 60%, clay 35%, and lithium oxide 5%. The alumina may be partly replaced by clay or a zirconium compound and other ingredients such as chromium oxide. The lithium compound may be partly replaced by or used in addition to magnesium oxide, zirconia, or beryl. The material thus produced may be ground and used as grog preferably with an equal proportion of clay in the manufacture of a porcelain for insulators such as spark plugs, etc.

Refractory crucibles. C. J. BROCKBANK. Brit. 322,476, Jan. 29, 1930. Relates to the manufacture of crucibles of the kind consisting of graphite, with or without silicon carbide, and a clay, ceramic, or carbonaceous bond, and consists in adding titaniferous material to the composition, or in applying such material to the molded article, so that the crucible can be fired at vitrification temperatures whereby a crystalline structure and a glazed surface are produced. Suitable titaniferous materials are titanium dioxide, rutile, titanium silicate, and titanium aluminate. In an example, a composition comprising from 30 to 60% flaked graphite, 17% finely powdered silicon carbide, 30 to 45% ball clay, and 1 to 5% titanium dioxide is molded into crucible form and fired to a temperature between Seger cones 5 and 10.

Furnace walls. O. NYGAARD. Brit. 322,594, Jan. 29, 1930. An outer permanent furnace wall has a number of supports projecting from its inner surface and a spaced inner lining is built up of unbonded refractory brick units, each unit comprising brick suspended from the supports and filler brick loosely supported upon the suspended brick, the joints being overlapped to prevent leakage of air from behind the lining.

The supported brick are in horizontal rows of pairs, the brick having two rear side flanges, a bottom flange, a top flange, and two rear suspension lugs adapted to fit over the supports.

Refractory material. ARTHUR SPRENGER. Fr. 662,190, Oct. 1, 1928. A refractory material is obtained by heating to a high temperature oxides of Al, Si, Mg, and Cr mixed in such proportions that chromic compounds are formed free from SiO_2 and Al_2O_3 and the Al_2O_3 is saturated by MgO and SiO_2. (*C.A.*)

Refractory materials. SOC. ANON. DES ÉTABLISSEMENTS A. VALUY. Fr. 663,610, Nov. 7, 1928. The surface of refractory materials is rendered nonporous by treatment with a very high temperature flame. A more refractory material may be injected into the flame in powdered form. (*C.A.*)

Production of pure alumina. SALZWERK HEILBRONN A.-G., K. SCHMIDT GES.M.B. H., AND K. FLOR. Ger. 455,472, Feb. 27, 1925. The dross obtained in melting aluminium is sieved to remove coarse aluminium prills and digested with hydrochloric acid to obtain a relatively pure solution of aluminium chloride, which is then saturated with hydrogen chloride, whereby $AlCl_3$, $6H_2O$ is precipitated. This is washed with concentrated hydrochloric acid and calcined to obtain alumina and hydrochloric acid for use again. (*B.C.A.*)

Terra Cotta

Acoustic correction of auditoriums. F. R. WATSON. *Eng. News Rec.*, **104** [3], 105 (1930).—The acoustic faults in a room are due almost entirely to the reflection of sound from the boundaries. The chief fault is reverberation, or excessive prolongation of sound, whereby succeeding words in speech overlap and produce confusion for auditors. The correction for reverberation lies in the introduction of absorbing materials in calculated amounts, thus assuring good acoustics for a room. Sometimes echoes are present with curved walls and these require special treatment. A number of commercial products are now available for the purpose of acoustic correction. These vary from soft materials like hairfelt to semihard fiber boards and acoustical plaster and tile. W.L.

Color in architecture. ANON. *Clay-Worker*, **93** [2], 135 (1930).—Attention is called to the great mosque at Delhi, the Red Palace of Aurungebe, in red, the city of Jaipur in pink, etc., to show that color in architecture is not new. E.J.V.

Color in clay. ANON. *Brick Clay Rec.*, **76** [2], 102 (1930).—Heretofore, color has been used chiefly as a form of polychrome decoration on large buildings, but the present swing is away from the drabness of tonal effect which has characterized large cities with use of full body color in washable surfaces. E.J.V.

Bullock's Wilkshire department store. JOHN AND DONALD B. PARKINSON. *Arch. Rec.*, **67** [1], 51–69 (1930).—The exterior face of the building in Los Angeles is terra cotta, trimmed with deep-green copper spandrels. Interiors are variously treated with metal, marble, plaster, wood, and glass. E.P.R.

Early Florentine architecture and decoration. EDGAR W. ANTHONY. *Arch. Rec.*, **67** [1], 156 (1930). E.P.R.

Standard practice in design of chimneys and fireplaces. ANON. *Arch. Rec.*, **67** [1], 39–44 (1930).—For oil-burning equipment used in connection with domestic heating boilers and furnaces the prime requirement is that there be uniform draft of low intensity. A chimney with $^2/_3$ as much flue area is required for an oil burner as when coal is used. All chimneys should be of brick or stone laid in Portland cement mortar, reënforced concrete (in earthquake regions), and should extend at least 3 ft. above the point of contact with a flat roof or 2 ft. above the ridge of a pitch roof, and should be properly capped with terra cotta, stone, or other approved incombustible weather-

proof material. Brickwork or reënforced concrete of smoke flues of all boilers, furnaces, and large cooking ranges, should be at least 8 in. in thickness and lined with flue tile. Minimum chimney flue sizes and heights recommended for furnaces and low-pressure steam and hot water boilers are given. The circular flue has been determined from experience to be the most efficient but because of construction difficulties the square or rectangular flue is in more general use. Flue area must be increased with a greater elevation above sea level because of more rarefied air. Also, the height of the chimney must be increased. Mortar used between the joints of flue linings and in the portions of a chimney above a roof or otherwise wholly exposed to weather should be mixed 1 part Portland cement to 3 parts sand. Fire brick used for the lining of flues or facing the interior of fireplaces should be laid in fireclay mortar. E.P.R.

Reproduce handmade tile by machine. ANON. *Brick Clay Rec.*, **76** [3], 200 (1930).—"True Tile," manufactured by the Alhambra Kilns, Inc., Calif., is a machine-made replica of the old Spanish and Mexican roofing tile made years ago by molding clay around the thighs of the Mexican workers. The machine-made tile is more uniform in size and is smoother in finish than the older hand-made varieties, but is almost double the thickness of the ordinary red roofing tile and is graduated in thickness so that it presents a corrugated appearance when laid. It is being manufactured in a number of tints, ranging from an old gold to a brown. E.J.V.

Action of cold on tile. ANON. *Rev. mat. constr. trav. pub.*, No. 243, pp. 259–60B (1929). A.J.M.

White Wares

Standardization of feldspar classifications. ANON. Bur. Stand., *Tech. News Bull.*, No. 153, p. 2 (1930); *Commercial Stand. Monthly*, **6** [7], 214–15 (1930).—Feldspar, one of the important components of porcelain enamel, many kinds of glass, vitreous china, pottery, etc., has long been a source of misunderstanding between buyer and seller because of its widely variable character and absence of generally recognized quality designations. Formerly the material was bought largely on the basis of geographical location of deposits from which the material was ground, but this has been found to be unreliable criterion, since variations exist within the same deposits. With the closer control of production in the ceramic industry the users of feldspar are seeking more specific information so as to reduce the variables in the finished product arising from this source. To meet this need the producers of feldspar, through their trade organization, The Feldspar Grinders' Inst., requested the division of trade standards of the Bur. of Standards to coöperate in the establishment of a standard classification that will become universally understood in the language of their industry. A tentative commercial standard classification, based on fineness and chemical tests was discussed at a Conference held Jan. 14, 1929. For the proposed standard tests see *Bull. Amer. Ceram. Soc.*, **9** [1], 12 (1930); *Ceram. Abs.*, **9** [3], 207 (1930). R.A.H.

Solubility of quartz and clay in feldspar. C. W. PARMELEE AND C. R. AMBERG. *Ber. deut. keram. Ges.*, **10** [12], 576–77 (1929); see *Jour. Amer. Ceram. Soc.*, **12** [11], 699–710 (1929) and *Ceram. Abs.*, **8** [12], 901 (1929). F.P.H.

New ceramic insulating material. ANON. *Ceram. Ind.*, **14** [2], 204 (1930); *Brick Clay Rec.*, **76** [5], 338–40 (1930).—The properties of a new ceramic product to which the proprietary name of "Thyrite" has been given is described. The new material, which was developed after five years' research at the General Electric Co. ceramic plant, Pittsfield, Mass., consists of clays, carbon-silicon carbide (Carborundum) and carbon, its outstanding merit consisting of its acting as an insulator at a given voltage, but decreasing its resistance and becoming a conductor as soon as the voltage is sufficiently increased. Disks made of the new material for use in lightning arresters for the protection of power

stations against the damaging effect of lightning are described. These disks have a resistance of about 50,000 ohms when 100 volts are applied to the parallel faces. When the voltage is increased to 10,000 volts, resistance decreases to less than one-half ohm. The damage to the power plants of the U.S. runs into many millions of dollars annually, and this new material, which in color resembles black slate, will eliminate these losses. The mechanical properties of the new material are virtually the same as those of dry-process porcelain. It can be molded, like electrical porcelain, to any electrical shape required, and finished by metal-spraying. F.P.H.

Tests on suspension insulators after ten years' service. A. S. VENKATESWARAN AND V. GANGULY. *Jour. Indian Inst. Sci.*, **10** [B], 1–19 (1927).—A number of suspension insulator strings consisting of four standard ten-inch units were tested, after ten years service, for deterioration. The results of flash-over tests on the units and on the strings are given together with the measurements of the voltage gradient by means of a condenser bridge and an auxiliary transformer. Some of the sources of errors and difficulties encountered are discussed. A.A.

Measurement of voltage gradient on a string of suspension insulators. G. YOGANANDAM AND R. K. SEN. *Jour. Indian Inst. Sci.*, **10** [B], 21–35 (1927).—Several methods of measuring the voltage distribution on a string of suspension insulators are described and the distribution under different conditions studied. A theoretical investigation of the voltage distribution under approximately known conditions is given together with the experimental verification for a string of new Canadian porcelain cap- and pin-type line insulators. A.A.

Suspension insulator testing. G. YOGANANDAM. *Jour. Indian Inst. Sci.*, **10** [B], 43–49 (1927).—Experiments on the effects of a defective and dusty insulator upon the voltage gradient along the string are described. A new method of testing is described in which an auxiliary string of insulators is used. Experiments on a full-size section of a 75-kv. three-phase aluminum steel-cored transmission line are described. Comparative results are given showing the simplicity and usefulness of low voltage testing when a valve detector is employed. A.A.

Characteristics in important ceramic clays. GUSTAV KEPPELER. *Ber. deut. keram. Ges.*, **10** [11], 501–22 (1929).—The following properties of a number of European clays are given: (1) rational composition, (2) particle size, (3) amount of organic material present in the clays that is soluble in 10% NaOH solution, (4) p_H of clay slips, and (5) amount of NaOH required to completely deflocculate the various clay slips. F.P.H.

Sources of yellow discolorations on porcelain. R. RIEKE AND W. FAUST. *Ber. deut. keram. Ges.*, **10** [12], 567–76 (1929).—The effect of various amounts of Fe_2O_3 and TiO_2 on the color and translucency of porcelain fired to cone 15 under oxidizing and reducing conditions was investigated. All materials used in the work were analyzed for TiO_2 and Fe_2O_3. The results obtained in the normal porcelain firing (reducing) are summarized as follows: (1) When the Fe_2O_3 content of the body has reached 0.8% the body is gray: above 1% Fe_2O_3 the color of the body and glaze is distinctly yellow; (2) the presence of 0.2% TiO_2 with 0.6% Fe_2O_3 colors the body and glaze a dark gray; (3) the upper limit of Fe_2O_3 concentration in the glaze is about 0.5%. The effect of the kiln atmosphere on the discoloration of glazes and bodies is discussed. F.P.H.

Change in volume during use of fired clay bodies. ANON. Bur. Stand., *Tech. News Bull.*, No. 153, pp. 1–2 (1930).—To study the effects of composition of the body on the expansion caused by the autoclave treatment, several bodies within the following range of composition, *i.e.*, clay 48 to 56%, flint 26 to 34%, and feldspar 14 to 18% were made and subjected to a 3-hour treatment at 150 lbs./in.^{2} steam pressure. Expansions due to the autoclave treatment were taken on the bodies fired to cones 5 to 6, 8 to 9, and 11 to 12. It was found that practically a linear relationship existed

between the percentage of expansion and the cone firing temperature. Results showed that on replacing clay by feldspar and with the flint constant, there was an increase in expansion. On increasing clay at the expense of flint, with feldspar constant a greater expansion was secured. The changes in expansion within the above body limits were small indicating that little can be done in the way of decreasing the expansion by a variation of the feldspar-clay-flint content. Samples of commercial bodies made in the form of bars were subjected to the above autoclave treatment. The changes in length of the following tile were measured: buff wall tile expanded 0.057% (absorption 6.6%); a cream wall tile expanded 0.016% (absorption 2.1%); a terra cotta body expanded from 0.045 to 0.056% with absorptions of 11.2 and 12.5%. White semivitreous dinnerware expanded 0.071% (absorption 9.6%) and ivory semivitreous dinnerware expanded 0.065% (absorption 7.8%). R.A.H.

Continuous wet process for ceramic slip. ANON. *Eng. Progress*, pp. 239–40 (1929); *Ceram. Ind.*, **14** [1], 61 (1930).—A description is given of a countinuous wet process for the grinding and preparation of the slip from raw material to the finished product. The process is entirely automatic and results in the saving of a great deal of labor. F.P.H.

Whiteware industry of West Virginia. W. A. KOEHLER, E. K. KOOS, AND K. E. BUCK. W. Va. Univ., *Eng. Expt. Sta. Bull.*, No. 5 (1929).—The term "whiteware" in this bulletin includes porcelain and china tableware, white earthen tableware, sanitary ware, floor and wall tile, electrical porcelain, high-tension electrical insulators, and refractory porcelain. The number of plants producing various types of ware and value of annual production are given. The following tables are given: (1) potteries of W. Va. producing whiteware; name of company, location, type of ware produced, number of workers; (2) whiteware production in the U.S.; (3) prices of pottery raw materials; (4) chemical and physical properties of domestic china clay, (5) English china clay, (6) domestic ball clay, (7) wad and sagger clays, (8) chemical properties of feldspars and flints; (9) comparison of domestic production and imports of kaolin and china clays; (10) relative costs of domestic and imported china clays; (11) summary of the potteries (W. Va.) using foreign and domestic clays; (12) feldspars used by W. Va. potteries; (13) glaze materials used by W. Va. potteries; (14) recipes for vitreous and semivitreous wares; (15) car tunnel kilns used by W. Va. potteries; (16) maturing temperatures and lengths of firing in periodic kilns used by W. Va. potteries; (17) classification of kilns in W. Va. potteries; and (18) import duties on some whiteware. A detailed flowsheet for the manufacture of vitrified hotel china is given. The results of a questionnaire sent to the various potteries show that the most serious problems are foreign competition and the utilization of waste. Twenty-eight pages by Koos explain in great detail the manufacture of vitrified hotel china. The following points are discussed: body composition, body preparation, forming the ware, casting, the green house, bisque firing, cleaning, decorating, glazing, glost firing, saggers, inspection, and shipping. B. has contributed a section on the manufacture of ceramic floor and wall tile. This includes (1) raw materials, (2) preparation of the body, (3) fabrication of the ware, (4) firing of the body, (5) inspection, and (6) assembling and packing. Illustrated. See also *Bull. Amer. Ceram. Soc.*, **9** [3], 57–60(1930). A.J.M.

American methods of pottery manufacture. JOSEPH BURTON. *Pottery Gaz.*, **55** [631], 85–91 (1930).—Impressions of the English manufacturers who visited the American ceramic plants in May, 1929. E.J.V.

Quality in pottery. JOSEPH BURTON. *Pottery Gaz.*, **55** [632], 302–305 (1930).—The processes involved in the making of pottery ware fall into two groups. The first of these consists of the manipulative processes such as the preparation of the clay, shaping, modeling, painting, etc., which are completely under the control of the craftsman, and are, indeed, his chief means of direct expression. The other group consists

of the firing processes, in which chemical and physical changes are brought about which are only indirectly and incompletely under the control of the potter and are in fact the manifestation of the interplay of natural forces. The methods of shaping are discussed, especially that of throwing on the wheel. There are several distinctive features of pottery glaze which differentiate it from glass and also from enamel. It is not melted in the mass but always in a comparatively thin layer in direct contact with a pottery body with which it is closely related chemically. There are a series of continuous and progressive reactions taking place between the ingredients of the glaze themselves and between these, separately and collectively, and the body, but all these reactions are arrested at the moment when the firing is stopped and the glazed ware is allowed to cool. Various properties of glazes are described and it is pointed out that all these properties may be made manifest by the potter who has the opportunity of holding and making permanent, transient, and elusive effects, and so of obtaining qualities which are specifically and essentially pottery qualities. Underglaze colors are mineral compound substances which are carefully prepared so that they may be suitable for their purpose and which are applied to the surface of the clay or fired pot before the application of the glaze. The various complicated effects possible are described. Porcelain is the only type of pottery in which the body material itself has high aesthetic quality. The body and glaze of hard-paste porcelain are very closely related in chemical constitution, and when fired at the high temperature of the porcelain kiln they so combine that there is no definite line of demarcation between them, and the material quality of the glazed ware is a combined body and glaze quality. The pottery modeler does not work in the finished material, but only in the unfired clay. The qualities developed, however, during the firing process should have due consideration in the method of treatment, although the imagination, the individuality, or artistry of the artist-craftsman has freer scope for expression and plays a more important part in the production of modeled figures than in that of other pottery forms. Artistic quality is paramount here. When the artistic and aesthetic qualities are harmoniously blended together there is obtained perhaps the highest degree of interest and beauty which it is possible to achieve in pottery. E.J.V.

Buckling of floor tile. N. D. Wood. *Pottery Gaz.*, **55** [632], 261–63 (1930).—A tile floor, laid in cement, will sometimes buckle. The fundamental cause of the buckling of floor tile was the contraction of the cement, and this could largely be governed by the conditions under which the floor was laid. The wetter the conditions the less the contraction and the less the tendency to buckle. There was a definite relationship between the buckling of floor tile and the crazing of wall tile. A wall tile would be subject to exactly the same contraction strains as a floor tile. These strains, however, would be more localized and less acute in the case of the wall tile, for the reason that the bedding cement was supported by a rigid backing. A porous wall is to some extent elastic, and would be pulled into a slight arch by the cement, but the glaze of the tile, being vitreous and comparatively brittle, would be incapable of bending sufficiently with the tile, and crazing would result. The normal tendency of a tile toward crazing was greatly augmented when it was bedded in cement. In the case of floor tile the most efficacious remedy was found to be to keep the cement wet during the setting period. Tests carried out with a view to discovering whether substances, when mixed with cement, would have the effect of minimizing the contraction without militating against the strength of the mixture showed that plaster of Paris, lime, and alum would give the most promising results, reducing the contraction by about one-third, while not greatly prejudicing the strength. Some of the substances which proved most effective in reducing the contraction unfortunately destroyed the strength of the cement. E.J.V.

Cutlery marking of chinaware. ANON. Bur. Stand., *Tech. News Bull.*, No. 153, p. 1 (1930).—The attention of the Bureau has been directed a number of times to the so-called cutlery marking of tableware. When such objects as silver-plated knives are drawn across tableware a mark results which cannot be removed by washing. A study by the Bureau has indicated that the trouble is caused by a slight, almost inappreciable roughening of the surface of the ware because of its being fired in the presence of gases from sulphur in the kiln. Tests made by introducing as little as 0.0625% of sulphur dioxide in an electric muffle in which ware was being fired which did not show cutlery marking previous to treatment with gas after such treatment gave ready evidence of cutlery marking. It was also found that the treatment of the test ware with solutions of ammonium acetate, caused lead sulphate to be dissolved from the surface of the glaze. Buffing would remove this surface layer also so that the ware would not mark. R.A.H.

Mechanical strength of (Austrian) porcelain insulators. FRED. SCHUSTER. *Elektrochem. Maschinenbau*, **47**, 1102–1104 (1929).—Tests are recorded. (*C.A.*)

Soldering metal to porcelain is now practicable. D. A. JOHNSON AND W. K. NAYLOR. *Elec. Jour.*, **26**, 566–67 (1929). (*C.A.*)

PATENTS

High-tension insulator. PHILIP B. STEWART. U. S. 1,745, 234, Jan. 28, 1930. Combination with a string of insulators for suspending a conductor from a stationary support of electrode means carried by the intermediate portion of the string of insulators for providing a flash-over path at one side thereof, and a fuse connected with the conductor interposed in series with the path and adapted to be blown upon the occurrence of a flash-over for extinguishing the arc.

Mold for stoneware jars, etc. JOHN M. STRAND. U. S. 1,747,192, Feb. 18, 1930. A mold for stoneware articles having an open end, the mold being provided with a recess for forming a bead on the outside of the molded article, the mold having two oppositely arranged outwardly extending depressions below the recess, slides carried by the mold and movable over and away from the depressions, the slides having molding spaces therein for coöperating with the depressions to mold projections on the article extending beyond the bead formed by the recess, and a horizontally-disposed ring on the mold having pin and slot connections with the slides for moving the same into and out of molding position as the ring is turned, and axially movable arcuate piercing pins slidably arranged on the mold adjacent the depressions for piercing the projections formed by the depressions and slides after the slides have been moved outwardly, the slides being movable outwardly beyond the bead area formed by the recess.

Equipment and Apparatus

Enamel for chromium tank racks. ANON. *Brass World*, **26** [1], 18 (1930).—A new waterproof rack enamel has been especially developed by the Maas and Waldstein company for protecting racks used in chromium plating. This preparation has been adequately tested, according to the makers, and has been found beneficial in protecting racks from the action of chromium solutions while supporting work on which chromium is being deposited. E.P.R.

An epidiascope for lecture experiments. ALFRED STOCK AND HANS RAMSER. *Z. angew. Chem.*, **42** [52], 1165–69 (1929).—Description of a new epidiascope manufactured by Leitz with a tabulation of some of its applications. L.T.B.

Molybdenum for electric furnace resistance. ANON. *Mining Jour.*, **163** [4861], 872 (1928).—Molybdenum wire is coiled around a tube which is of gas-proof material,

the whole being inclosed in a gas-proof tube and the space between is filled with methyl alcohol vapor to prevent oxidation. This furnace will reach 1500°C in 1½ hours and will operate at 1450°C safely. Methyl alcohol must be supplied constantly.
E.C.C.

Clayworking equipment. ANON. *Clay-Worker*, **93** [2], 120–33 (1930).—In keeping with the trend toward modernization of plants by clay products manufacturers, a request was sent to the various manufacturers of clayworking machinery for information regarding their equipment for clay plants. Starting with descriptions of various makes of crushers and grinders, clay cleaners, brick machine screens, combination machines, automatic cutters, mixers and feeders, drier equipment, driers, systems of drying and firing, kilns and kiln equipment, temperature regulators and recorders, handling equipment, and delivery systems are discussed. Illustrated. E.J.V.

Cutting apparatus for brick and similar products. P. RENAULT. *Rev. mat. constr. trav. pub.*, No. 243, pp. 257–58B (1929).—Various types are shown and discussed.
A.J.M.

Eliminating noise in brickmaking machinery. W. E. SCHAPHORST. *Brick Clay Rec.*, **76** [3], 192 (1930).—Sometimes the vibration of brick machinery causes much undesirable noise and distress. One way to stop this vibration is to lay a heavy foundation under the machine, so heavy that the comparatively small machine will be unable to cause the heavy mass to vibrate with the machine. Two objections to this method are its expense and its great weight. Another method is to use cork board, restricting the area thereof so that the cork will be under the right amount of compression. Cork board is ideal for this purpose because it is strong in compression, is highly elastic, is surprisingly durable, and does not rot. Its light weight is also a great advantage for use on second floors. E.J.V.

Belt rules. W. E. SCHAPHORST. *Brick Clay Rec.*, **76** [3], 190–92 (1930).—Some handy kinks and rules pertaining to belting which are the result of personal study of belt problems are presented with mathematical explanations for each. E.J.V.

Modern methods of ascertaining specific gravity. W. A. BENTON. *Chem. and Ind.*, **48**, 1145–52 (1929).—A series of instruments recently devised by the Avery Co. of Birmingham is described. H.H.S.

Developments in ceramic industry. G. HELM. *Z. Ver. deut. Ing.*, **73** [28], 985–91 (1929).—A review of the recent developments in Germany of ceramic processes and of machines used in the ceramic industries is given. L.T.B.

New idea in tile shipping. ANON. *Clay-Worker*, **93** [2], 146 (1930).—A new system consisting of two steel containers with wheels mounted on rails on a flat car, with heavy spring bumpers located at each end of the car and between the containers, the containers having side doors for loading and holding a total load of about 24 T. of ware is being looked into as a scheme to be used in shipping tile without the danger of breakage due to sudden impacts received during the switching of freight cars. The entire idea of the scheme is that the containers move forward and backward on the rails against the spring shock absorbers. Unloading or draying to jobs is accomplished by drawing the loaded members onto trucks and delivering them for unloading at the job. E.J.V.

Gas for drying clay. K. H. CREE. *Gas Age-Rec.*, **65** [3], 71 (1930).—The Abrasive Co., employs a gas drier for clay, which is highly satisfactory from an operating and economical standpoint. Gas has been found to be most effective. Clay is broken up into small particles before delivery to the drier having a moisture content of from 1 to 30%. The drier consists of an outer drum or shell of sheet steel, 21 ft. long and 24 in. in diameter, with an inner mandrel or retort 18 in. in diameter and the same length as the outer shell. The inner retort is constructed of alloy metal, and the clay to be dried passes around it. The drier is installed at an angle of about 20°. It is

supported on two sets of pulleys, and is rotated on large bearings on the pulleys. Inside the inner drum, eccentrically placed, is a 3-in. lava tip gas burner. The burner has sixty tips placed at 3-in. intervals, from which the gas burns with a smooth, sharp flame. This burner gives a capacity of 12,000 cu. ft. per hour, and the drier has an operating capacity of from 300 to 600 cu. ft. of clay per hour, depending upon the moisture content of the raw material. The burner is supported only at the charging and discharging ends of the retort. It is kept from sagging by means of a steel strip, the length of the burner, placed inside the pipe and spot-welded at regular intervals. This construction provides extreme rigidity and insures the burner standing high temperatures without detrimental effects. F.P.H.

Drying tunnels. ANON. *Tonind.-Ztg.*, **54** [3], 38–39 (1930).—Continuous currents in drying tunnels are more advantageous than counter currents for drying ware as the fresh damp pieces can be more safely exposed to higher temperatures than partially dried ware; and the latter, when using counter currents, are being periodically exposed to more hot gases whose temperature, therefore, must be carefully regulated. Condensation also takes place on the sides exposed to the action of the gases, which increases the water content of the ware and may easily cause a clogging up of the interior of the drum. On the other hand, with a continuous current, the gases having a temperature of 600°C come in contact with the product having a temperature of 15°C and a very intensive exchange of heat follows. On leaving the drum the gases have a temperature of about 110°C and the products 80°C. To reduce the great loss of heat in both processes, the gases leaving the drum are collected by a circulating pipe and mixed with the incoming gases whose temperature must not exceed 600°C. M.V.K.

Contribution to the study of mechanical drying of ceramic products. RAOUL DE BLOTTEFIÈRE. *Rev. mat. constr. trav. pub.*, No. 243, pp. 245–54B (1929).—B. discusses the theory of drying and presents data on the drying characteristics of several French clays. Drawings of driers are given. A.J.M.

Junior F R H machine. ANON. *Brick Clay Rec.*, **76** [2], 128 (1930); *Clayworker*, **93** [2], 125 (1930).—The Fate-Root-Heath Co. of Plymouth, Ohio, has recently added to its line another brick and tile machine, called the F R H Junior. The machine is completely equipped with roller bearings and has a capacity of from 5000 to 8000 brick per hour, or the equivalent in hollow ware. It is a combined auger machine and double-shaft pug mill, with overlapping, interworking pug knives and is very similar to this company's F R H machine, which is well known by the heavy clay product manufacturers. Details of construction are given. E.J.V.

Drying paving brick in 24 hours. ANON. *Brick Clay Rec.*, **76** [3], 188 (1930).—Three-inch pavers are being dried at the Roseville Brick Plant in 24 hrs. in a special tunnel drier designed by J. L. Carruthers, Ohio State University. This drier is equipped with a special hot, high-humidity chamber in which the brick are heated before being run into the regular drying chamber. The operation of this equipment is based on the theory that if a brick is uniformly heated without loss of moisture before drying, the drying rate can be materially increased without injury to the product. E.J.V.

Classifier efficiency, an experimental study. A. W. FAHRENWALD. *Mining and Met.*, **11** [278], 22 (1930).—The ratio "weight divided by surface" of sand grains is a widely varying factor for ore grains passing a given sieve aperture. Closed circuit classifier efficiency is not theoretically accurately expressed on the basis of sieve analysis. Closed circuit classifier efficiency shows to much better advantage on the basis of ideal classification than on the basis of sieve analyses. The efficiency of the classification studied is about 60%. This suggests opportunity for further useful research in the field of this type of classification. Classifier efficiency on the basis of removal of finished product shows up to better advantage than on the basis of over-all efficiency. F.P.H.

Weighing and weighing machines. F. H. POOLEY. *Chem. and Ind.*, **48**, 1152–56 (1929).—The nature of product of the factory, location of weighing machine, types of machine most suitable for the work, and general considerations such as the time factor and government regulations, are discussed. H.H.S.

Electric dewatering. ANON. *Clay-Worker*, **93** [2], 147 (1930).—Experiments in dewatering clay suspensions by electrophoresis are being conducted at the Univ. of Washington. The operation consists of passing a direct current through the suspension and providing a mechanical means of removing the damp mass from the electrode upon which the particles collect. Clay particles suspended in water carry a negative charge and will pass to the anode, which is a cylinder of type metal rotating slowly through the slip. The cylinder collects a plastic coating of clay while immersed and is scraped clean during the exposed part of its revolution. When the clay suspension is renewed as fast as used, such a machine provides a continuous and mechanical method of dewatering. With the best acting clays the water content has been reduced until the clay is in the plastic working condition suitable for molding pottery or other ceramic ware. Some indications noted as a result of tests of several clays in a small machine are (1) different clays exhibit individual characteristics under the influence of a unidirectional electric current; (2) thorough dispersion seems to be an essential requirement for good results; (3) the addition of an acid coagulates the particles into clusters and retards the movement; (4) the most efficient operation with the small machine used was obtained when the clay suspension was not depleted below 15% solids. E.J.V.

High temperature technique. OTTO RUFF. *Z. angew. Chem.*, **42** [31], 807–10 (1929).—Description of a high-temperature carbon resistance furnace provided with an X-ray apparatus for studying ceramic refractories at high temperatures. L.T.B.

Efficiency of a tube mill. DIPLING ØSTERLIN. *Concrete*, **35** [6], 105–107 (1929).—Ø. discusses (1) the work performed in the tube mills, (2) classification of charge units, (3) layers of charge units, (4) working weight of charge, and (5) total H.P. required. E.A.H.

Use and cost of compressed air. ROBERT L. LEWIS. *Mining and Met.*, **11** [278], 42 (1930).—Theoretically compressed air is not utilized efficiently in the rock drill and yet no serious competitor to the air-driven drill has appeared. Maintenance of the compressed-air system in the best condition is necessary to attain reasonable approach to the high efficiency. Leaks in distributing lines must be avoided, the intake of the compressor should be from a supply of cool air. The choice between single-stage and two-stage compression depends largely on cost of power, altitude of the plant, capacity required, and the probable life of the plant. For capacities up to about 300 cu. ft. per min., a single-stage machine may be used for a pressure up to 100 lb., but for larger capacities and higher altitudes the advantage lies distinctly with a two-stage compressor. The article concludes with a compilation of "plant" costs for sixteen different installations with a brief description of operating conditions. F.P.H.

Clay screening. ANON. *Clay-Worker*, **93** [2], 119 (1930).—Interesting progress is being made in the mechanics of clay screening not only in devising and improving machines with which to do the work, but also in the development of new and better materials for the screen wire and cloth. E.J.V.

Magnetic separators insure better quality. ANON. *Brick Clay Rec.*, **76** [2], 123–24 (1930).—Several clay manufacturers have adopted a piece of equipment which is new in clay products manufacturing and which is having an important influence on the quality of ware produced. The magnetic separator is used in removing iron from the clay or shale before it is introduced into the preliminary grinding. Some installations of note are found at the Alton (Ill.) Brick Co., Metropolitan Brick Co., Bessemer, Pa.,

and the Adel Clay Products Co., Redfield, Iowa. The installations at these plants are described in some detail. E.J.V.

Variable speed-transmission for smoother operation. ANON. *Brick Clay Rec.*, **76** [2], 122–23 (1930).—Variable speed-transmission units are just beginning to be applied to clay products manufacture. The electrification of the clay industry, which is being rapidly accomplished, is constantly bringing before the clay manufacturer the problem of speed changing, the satisfactory solution of which is a necessity to the economical and efficient operation of clay machinery by electric power. Manufacturers who have taken advantage of variable speed-transmission service have installed it on feeders, dry presses, represses, tunnel kiln car pushers, stokers, and gas compressors. Variable speed transmission would be desirable on combination or straight auger machines. More satisfactory results could be obtained by being able to change the speed of the machine in accordance with the size of the ware. Some installations now in operation in various plants are described. E.J.V.

Thermo-elements in ceramic practice. G. A. HUNKELE. *Ceram. Ind.*, **14** [2], 216–18 (1930).—Rare thermo-elements under long continuous use slowly become hard and brittle. Heating a wire between a hardened part and a part retaining its original ductility, a parasitic current is developed. This counter e.m.f. accounts for old couples reading low. This can be counteracted by periodic re-annealing. Heating at too high temperatures in a reducing atmosphere alters couples. All volatile metals attack platinum very rapidly. Silicon vapors and CO particularly, will alter platinum. Impurities from protection tubes not gas tight set up what is technically known as the Becquerel effect. Let it be assumed, *e.g.*, that the platinum side of the platinum vs. platinum rhodium couple has absorbed silicon or a metallic vapor. Immediately dissimilar metals become in contact with each other, *i.e.*, platinum vs. contaminated platinum, and a foreign e.m.f. is generated. Rare elements can be brought back to their original condition by cleaning and annealing. This process will drive out the impurities which have been absorbed. F.P.H.

New laboratory furnace. ANON. *Gas Age-Rec.*, **65** [5], 150 (1930); *Glass Ind.*, **11** [2], 45 (1930); *Fuels and Fur.*, **8** [2], 274 (1930); *Amer. Glass Rev.*, **49** [20], 21–22 (1930).—A description of a small gas-fired laboratory furnace designed by F. H. Norton and C. L. Norton, Jr., was published in the March, 1930 issue of the *Journal of the American Ceramic Society*. For references see *Ceram. Abs.*, **9** [3], 191 (1930).

Recent developments in electric furnaces. DONALD F. CAMPBELL. *Mining Jour.*, **165** [4887], 310–11; [4888], 331–32; [4889], 358 (1929); for abstract see *Ceram. Abs.*, **12** [6], 423 (1929). E.C.C.

BOOKS

Filtration and Filters. J. A. PICKARD. Ernest Benn, Ltd., London, 1929. Price 45s.—This book deals comprehensively with filtration problems. There is a chapter on metafiltration, a section on the mathematics of filtration by A. J. V. Underwood, and an account of glass filters by P. H. Prausnitz. H.H.S.

Materials Handling Equipment. EDWARD J. TOURNIER. McGraw-Hill Book Co., Inc., New York. 371 pp. Price $4.00. Reviewed in *Gas Age-Rec.*, **65** [4], 108 (1930).—This book, the most recent addition to the Industrial Management Series published by McGraw-Hill Co., treats in detail the mechanics and economics of handling coke, coal, ashes, granular materials, waste, and packages. It opens with an interesting, although brief, historical sketch of materials handling equipment, followed by comprehensive definitions of hoists, elevators, cranes, conveyers, etc. F.P.H.

Drying and Processing of Materials by Means of Conditioned Air. D. C. LINDSAY. Carrier Engineering Corp. $3.00. 210 pp. Reviewed in *Brick Clay Rec.*, **76** [2], 132 (1930).—The intent of the book is to set forth the fundamental principles of the

drying and processing of materials by means of conditioned air, so that the manufacturer handling products sensitive to atmospheric conditions may be adequately acquainted with both the possibilities and limitations of this most important part of many manufacturing procedures. The book presents the subject of drying and processing coupled with the many accompanying phenomena so that any intelligent reader can understand it, yet the matter as submitted does not in its elementary simplicity offend the intelligence of the most highly trained technical mind. Many very interesting subjects are discussed, as the states of matter, molecular phenomena of water and water vapor, vapor pressure, absolute humidity, relative humidity, the measurement of water vapor in air, wet and dry bulb temperature, shrinkage during drying, case hardening, typical drying problems met with in specific industries, psychrometry and psychrometric charts, conversion tables, and many other important and interesting subjects. The book should be of unusual interest to clay products manufacturers, especially in the general discussion of drying in which clay is taken for an example. There is also a chapter devoted to drying of clay products. E.J.V.

Flexible Shaft Handbook. ANON. *Amer. Glass Rev.*, **49** [19], 22 (1930).—Through its industrial division the S. S. White Dental Mfg. Co. has issued the "Flexible Shaft Handbook" in which is described the various industrial uses for flexible shafts. E.P.R.

PATENTS

Drying ceramic articles in drying chambers. KARL LÜHMANN. U. S. 1,744,398, Jan. 21, 1930. Method of drying ceramic articles in a plurality of drying chambers, which comprises causing drying air to enter any one of the drying chambers and discharge into any other drying chamber, cutting off the supply of drying air, entering a chamber and directing it into another chamber containing partly dried articles and connecting the latter chamber in series with another chamber and emptying the first chamber.

Sand-handling and molding apparatus. MAX W. GOLDBERG. U. S. 1,748,124, Feb. 25, 1930. A sand-handling apparatus for discharging sand into an overhead receptacle, comprising an elevator and sand-conditioning unit, a discharge member in connection with the unit for directing sand into the receptacle, an endless belt movable below the discharge member for intercepting sand which has fallen from the discharge member without going into the receptacle and for directing some of the sand into the receptacle, and a chute below the endless belt and communicating with the elevator unit, for directing the rest of the fallen sand back into the elevator unit.

Jolleying pottery. W. G. BARRATT AND H. L. HOLDCROFT. Brit. 322,038, Jan. 15, 1930. A potters' jolley arm is made in two parts, connected by a vertical pivot so that the tool after being brought down into the mold by the lowering of the weighted arm, can be moved horizontally to produce undercut or "bellied" ware and moved back again to clear the molded article after the completion of the operation. Stops which limit the horizontal movement can be set to fix the parts rigidly together when producing straight or non-bellied ware.

Molding clay pots, etc. J. W. CRUIKSHANK. Brit. 322,804, Feb. 5, 1930. Articles of clay or other plastic material are formed by rolling the material against a mold surface and simultaneously tamping or kneading the material against the surface. As shown, applied to the manufacture of glass melting-pots, a chamber, adapted to be connected to vacuum through a pipe, houses apparatus comprising a rotary table supporting a mold to which material is supplied by a worm feed and is first spread over the mold bottom by a conical roller. A tamper is carried by a frame which is rocked by a serrated cam below the table engaged by a roller under the influence of a spring. The roller is carried by a telescopic, inclined shaft driven through gearing from a shaft which

also drives the table through bevel gearing. Holes in the mold bottom permit escape of air. After forming the bottom, the shaft and roller are withdrawn, side molds are placed in position and a second roller is brought into operation. The walls of the pot are made thicker than required and on completion, the tamper is withdrawn and the roller is moved laterally to reduce the wall to the desired thickness. The rollers and tamper are lubricated by fixed pads soaked in oil. Heated or dry air may be injected to hasten drying; or drying agents may be placed in the chamber.

Kilns, Furnaces, Fuels, and Combustion

Heat balance in rotary kilns. A. C. DAVIS. *Cement and Cement Manufacture* [England]; *Rock Prod.*, **33** [2], 55 (1930).—D. summarizes the operations in which heat is usefully expended, recovered, or wasted in rotary kilns. He gives a typical operation, citing the data required and the methods of deriving these. The following is offered as a heat balance in a rotary kiln:

Debits Heat expended in chimney gases from	B.t.u.	Percentage of standard coal
CO_2 ex-raw materials	8366	0.664
H_2O raw materials	144,692	11.480
Combustion gases	57,861	4.592
Excess air	3580	0.284
H_2O in coal moisture	4296	0.341
CO from incomplete combustion	2907	0.231
From dust and air moisture	2560	0.203
Heat required in dissociation of carbonate	91,120	7.232
Heat lost in clinker from cooler	4700	0.373
Total heat accounted for	320,082	25.400
Balance—unaccounted for	45,928	3.648
Total	366,010	29.048
Credits		
Coal calorific value	340,200	27.0
Exothermic reaction	17,880	1.419
Organic matter in slurry	7930	0.629
Total	366,010	29.048

W.W.M.

Merry-go-round tunnel kiln. ANON. *Refrac. Jour.*, **5** [51], 104 (1929).—A new circular Woodall-Duckham tunnel kiln has just been completed at the Doulton Works, Burslem. This kiln differs from others in that it does not utilize a number of cars running on wheels on rails but is in practice a roundabout. It is the floor of the kiln which travels and the arrangements for preventing the escape of heat between the sides of the floor and the sides of the kiln are almost perfect. The heavy floor has a steel shod base carrying a rack which is driven in two places by a pinion actuated by an engine which occupies a site in the center of the space surrounded by the circular kiln. The weight of the kiln bottom is carried on trunnions in the form of flanged wheels and the gas is put in at the top in one particular part of the kiln. Unfired crockery is filled into oval saggers or round fireclay boxes, the saggers piled up one on top of the other on the very slowly moving platform, and the load disappears into the tunnel to emerge later and in due course fully fired and ready for the next process. E.P.R.

Thermal balance in cement kilns. SOZZETTI. *Rock Prod.*, **32** [26], 96 (1929); for abstract see *Ceram. Abs.*, **9** [3], 158 (1930). W.W.M.

Kilns and kiln firing. II. Dunnachie continuous gas-fired kiln. S. R. HIND. *Trans. Ceram. Soc.* [Eng.], **28,** 148 (1929).—The Dunnachie continuous gas-fired kiln at the Glenborg Union Fireclay Co. is used in the same manner as all chamber kilns. A producer is used to make the fuel. For every chamber fired the air for combustion of the fuel supplied to that chamber is preheated by passing through ware which is cooling: the products of combustion pass onward through ware to be fired before being drawn off to the exhaust. As soon as a given chamber is fired up the gas supply to that chamber is shut off, that to the next chamber turned on, and the series of chambers in circuit moves one place forward. The producer used is fully described. The ware under fire was Glenborg fire brick fired to cones 14 to 15 and some special shapes. The atmosphere is, in general, strongly reducing except for a short period at the end of the run. The general design of the kiln is excellent, lending itself to the production of refractories of the highest quality. The kiln under discussion was substantially built and repairs are small with accessibility for repairs to the chambers quite favorable. **III. Belgian ring kiln.** *Ibid.*, 204–19 (1929).—The construction, setting, and firing of a Belgian ring kiln, together with photographs and drawings used for firing Stourbridge fire brick, are discussed. Five chambers were taken for the heat-balance experiment. The figures shown are very satisfactory and particularly the high ratio of flue-gas losses to radiation, etc., can generally be taken as a safe indication of efficiency in a continuous kiln. The fuel is distinctly low grade, but no financial improvement can be expected from the use of a better quality with its correspondingly higher price. Fuel consumption at 9.2% on fired goods is distinctly good for a firebrick kiln. This corresponds to 1.83 cwt. per ton of fired goods. The efficiency factor gives an unusually favorable comparison with the ideal intermittent kiln. This is ascribed largely to the very simple structure of the kiln, the absence of the dividing walls, and the substantial thickness of the walls and crown. The firing was not so uniform as could be desired. The bulk of the setting, judging by the Watkin recorders, attained about Seger cone 11 in No. 16 chamber. The trials in this and other chambers indicated an average for the whole kiln of cones 11 to 13. It would certainly seem advisable, in view of the results given, to fire the kiln with the aid of trials. Two sets of Seger cones, well placed, would be sufficient. For IV and V see *Ceram. Abs.*, **8** [11], 833–34 (1929). R.F.S.

Absorptive capacities of coal. B. P. PENTEGOV. *Gas Age-Rec.*, **65** [4], 102 (1930).—The degree of fossilization of coal is characterized by its colloidal state. Advance of fossilization is associated with decrease in the unsaturated, non-oriented carbon atoms and in the colloidal phase. Hence younger coals contain more hygroscopic moisture. P. classified coals according to their adsorptive capacity. Weathering decreases the adsorptive capacity. Similarly the absorptive power of coal is characteristic. The ratio of the value for coal to that for the corresponding coke is usually less than unity for bituminous coals, approximately unity for anthracite, less than unity for peat, and greater than unity (sometimes greater than 2) for brown coals. The ratio is reduced by weathering and increases with the depth of the coal stratum. The gas content of coals is also a function of their adsorptive capacity. Spontaneous combustion is apt to follow adsorption of sulphates and their reduction to sulphides. The greater the adsorption value of a coal, the greater the yield of ether-soluble hydrogeneration products by the Fischer method. F.P.H.

Fuel consumption of downdraft kilns. ANON. *Brit. Clayworker*, **38** [453], 374–75 (1930).—It is generally recognized that the fuel consumption of downdraft kilns is 10 to 12 cwt. per 1000 brick. It is by no means uniform, however, and depends on (1) the nature of the coal used, its calorific power, and size of pieces of coal; (2) design of

kiln and its condition, a badly designed or leaky kiln requiring much more fuel than a sound one; (3) skill with which the kiln is managed; (4) density of setting, *i.e.*, weight of brick in a cubic yard of available kiln space; and (5) variations in draft due to wind and weather. The variations in these conditions and their influence on each other and on the fuel consumption account for most of the differences in the fuel consumption of different downdraft kilns. Each one of the conditions is discussed in detail with suggestions for remedying them. R.A.H.

Fuel oil for industrial furnaces. L. D. BECKER. Amer. Soc. Engrs., Advance paper; *Trans. Amer. Soc. Steel Treating*, **17** [1], 147 (1930); for abstract see *Ceram. Abs.*, **9** [2], 124 (1930). E.P.R.

Improvements in gas producers. ANON. *Tonind.-Ztg.*, **53** [100], 1756–57 (1929).—A specially constructed ash plate with an inner ash receiver "system orb," is being used in gas generators to collect the ashes and slags which ordinarily accumulate in the generator pit. This apparatus facilitates the disposal of ashes and increases the efficiency of the generator. Its entire weight with accessories is only 5300 kg. for a generator of 2600 mm. diameter and it can easily be installed. M.V.K.

Fuel utilization in ceramic industry. A. T. GREEN AND A. J. DALE. Nov. Meeting of Inst. of Fuel, London; *Refrac. Jour.*, **5** [52], 160 (1930); for abstract see *Ceram. Abs.*, **9** [2], 121 (1930). E.P.R.

Influence of coal type on radiation in boiler furnaces. W. J. WOHLENBERG. *Trans. Amer. Soc. Mech. Eng.*, **51** [12], 235–46 (1929).—The results of an application of the methods and data presented in a previous A.S.M.E. paper (see *Ceram. Abs.*, **9** [3], 237 (1930)) on pulverized coal for a number of coals of widely varying composition are given. After an evaluation of radiation quantities for each of these coals, further investigation was made to find what quantitatively measurable property of coals might be most significant in differentiating one from another during combustion with respect to the quantity of energy which is transferred as heat to the walls of a boiler furnace. It was found that of the properties investigated, the calorific value serves as the most consistent and useful indicator of the radiation powers of a coal as burned in the pulverized form in boiler furnaces. E.P.R.

Re-forming natural gas in water-gas generators. WM. W. ODELL. *Gas Age-Rec.*, **65** [2], 33–36 (1930).—A satisfactory method has been found whereby natural gas can be re-formed in a standard carbureted water-gas set (with slight modification) making a gas of variable composition and density which can be mixed in various proportions with coal gas or other manufactured gas. The thermal efficiency of the process and the gas-making capacity of the set are high. Operation can be so conducted that the carbon entrained in the gas is reduced almost to zero. Propane, butane, or other hydrocarbon gas can be re-formed equally as well as natural gas. The chief variables influencing operating results have been studied and methods of control are well understood. The chief advantages to be gained by the re-forming of natural gas are as follows: (1) gas can be made using as raw materials coke (or coal) and natural gas (or other gaseous hydrocarbon), which has properties substantially the same as other standard manufactured gases for city distribution; (2) it can be made in standard equipment; (3) composition and density of the gas can be varied under control over an appreciable range; and (4) in certain instances where natural gas is available only during a part of the year, it can be used to reduce the cost in the holder of city gas when the re-formed gas is substituted for ordinary manufactured gas. F.P.H.

Economic use of electric furnaces. WIRT S. SCOTT. *Iron Age*, **124** [27], 1725–28 (1929).—Analysis of production costs, and electricity vs. natural gas in heat treatment of high-grade shovels. E.C.C.

Gas burner in top of kiln. ANON. *Brick Clay Rec.*, **76** [2], 124 (1930).—A gas

burner in the crown of a tunnel kiln near the discharge end of the furnace section installed in order that sufficient heat gets to the center of the setting, is a unique idea found on the two Harrop tunnel kilns at the Kier Fire Brick Co., Salina, Pa. E.J.V.

Tile fired with powdered coal. ANON. *Brick Clay Rec.*, **76** [2], 138 (1930); *Clay-Worker*, **93** [2], 132 (1930).—At the Ohio Clay Co., Cleveland, Ohio, powdered coal is being used to fire hollow tile in a Harrop tunnel kiln and reports state that satisfactory results have been obtained. Considerable tonnage is manufactured. E.J.V.

Economics of producer gas, fuel oil, and natural gas compared. III. JOHN W. ROMIG. *Glass Ind.*, **11** [2], 30–31 (1930).—Data and method required for investigating fuel oil as a tank fuel by making a heat balance is outlined. A typical example is worked out in detail. Various factors which may be altered to effect the results are enumerated and their effects explained. For Part II see *Ceram. Abs.*, **9** [3], 222 (1930). E.J.V.

Demand for gas and fuel oil shows gain. E. B. SWANSON. *Brick Clay Rec.*, **76** [3], 192 (1930).—An increase of 3.6% is shown in the demand for gas oil and fuel oil during 1928 over 1927. The ceramic industry is a user of gas oil and fuel oil, with a national distribution for three years: 1926, 3,216,850 bbls.; 1927, 3,270,036 bbls.; 1928, 2,878,531 bbls. E.J.V.

Lighting of continuous-fire kilns. J. WELTER. *Rev. mat. constr. trav. pub.*, No. 243, pp. 254–56B (1929); for previous abstract see *Ceram. Abs.*, **9** [1], 56 (1930). A.J.M.

Firing brick and clinker. H. MAGER. *Tonind.-Ztg.*, **53** [102–103], 1785–86 (1929).—The differences in the firing processes of ring and chamber kilns are outlined and the advantages of the chamber kilns, with alternate firing, over ring kilns for firing clinker, are pointed out. M.V.K.

PATENTS

Kiln-heating means. PHILIP D'HUC DRESSLER. U. S. 1,744,453, Jan. 21, 1930. An open-fired tunnel kiln having side walls enclosing an elongated kiln chamber, a series of separate burner chambers in one of its side walls, a conduit connecting the kiln chamber with the burner chambers for passing preheated air to the latter and fluid fuel-supply means associated with each burner chamber and adapted to operate as a jet ejector to draw air for combustion from the kiln chamber through the conduit at a rate substantially proportional to the rate at which fluid fuel is supplied by the means.

Gas producers. J. Y. JOHNSON. Brit. 321,422, Dec. 31, 1929. In the production of producer gas from granular fuel containing fuel dust, part of the gasifying agent is supplied below the fuel to keep the latter in suspension and part is admitted at different levels in the gasification chamber, the hot gaseous mixture containing fuel dust being then conducted through a large secondary gasification chamber. A heat accumulator may be provided in the producer and used for generating water gas after it has been heated in the period in which producer gas is made.

Carburetor for making carbureted water gas. ANON. Ger. 473,665, Jan. 1, 1927; *Gas Age-Rec.*, **65** [2], 53 (1930).—The carburetor is heated by the combustion of the blow gases. It consists of a hollow cylinder. A pillar is arranged in the carburetor, this ending close to the top of the latter and the oil atomizing and distributing device is located in the roof of the carburetor directly over the top of the column. The result is that the atomized oil does not come into contact with the top of the aforementioned column, or only a small part of it makes contact with the latter. The inlets for air and also for blow gases are arranged close to the roof of the carburetor and the top of the column. The latter is made hollow and the hollow part is connected to the outside by an opening in the bottom extending through the wall of the carburetor,

while the exit for the gases within the column is located at the top of the latter in the side walls. F.P.H.

Vertical small chamber oven for producing coal gas and oil gas. ANON. Ger. 473,486, March 6, 1927; *Gas Age-Rec.*, **65** [2], 53 (1930).—The oven is provided with vertical retorts. A chamber is located between the recuperators of the retort chamber and the gas outlet conduit. The chamber is used for gasifying the crude oil, the latter being heated by gases from the producer. F.P.H.

Low-temperature distillation of bituminous fuel. ANON. Ger. 475,283, Nov. 24, 1926; *Gas Age-Rec.*, **65** [2], 54 (1930).—The shaft furnace is provided with a number of pipes which are arranged one over the other in staggered position. The pipes form completely interconnected separating walls. F.P.H.

Kilns. JOSEF THIEL. Ger. 482,700, May 6, 1928. A double chamber kiln has an exposed flame, and employs the waste gas from one chamber to preheat the other. (*C.A.*)

Kilns. WM. L. HANLEY, JR. Ger. 482,791, Jan. 1, 1925. A double tunnel kiln is described. (*C.A.*)

Annular muffle kiln for fine earthenware. HERMANN KRUM. Ger. 483,967, Feb. 18, 1926. Details are given. (*C.A.*)

Fireproof kiln lining. G. POLYSIUS A.-G. Ger. 484,531, Sept. 29, 1927. A fireproof lining for kilns comprises foundry cement and corundum pressed and molded into a casing of fireproof cast-iron alloy. (*C.A.*)

Furnace for baking earthenware and porcelain. FRANÇOIS L. M. LEVALLOIS. Fr. 663,722, Nov. 9, 1928. (*C.A.*)

Geology

Development of clay lands from prospecting data. WM. R. CHEDSEY. *Bull. Amer. Ceram. Soc.*, **9** [2], 26–29 (1930).—The development of any mineral deposit for underground mining operations is an important part because the mining method to be used requires this development to precede it and any change in mining method usually requires a change in development. The prospecting data should be carefully considered and a mining method outlined after consideration of the various methods applicable, then an inspection made of the prospecting data to see if all necessary points are covered before development is started. Various types of development of mines are discussed in detail, the effect of the mineral layout on the method used being shown. It is pointed out that anyone having thoroughly prospected a clay bed and made an underground contour map would have little difficulty in deciding upon the type of mine opening and the plan of development for any suitable mining method. E.J.V.

Fundamental factors in testing mineral products with special reference to slate and related materials. OLIVER BOWLES. *Proc. A.S.T.M.*, **29** [II], 902–908 (1929).—Products of mineral origin are divided into two groups; (1) those made from crude raw materials that require smelting or other treatment, and (2) those that retain their natural structure and properties in the finished product. Examples of the first group are metals and alloys; of the second group, slates and building stones. In testing and establishing standards for materials in the first group, modifications in properties and composition can usually be made. In the second group no such modifications are possible, and adaptation for use must be accomplished by selection only; selection for use is, therefore, of paramount importance in this group. Manufacturers have before them the prodigious task of testing and classifying these natural products and diverting them to the uses for which they are best adapted. Problems of adaptation to use are complicated by the interdependence of materials used in conjunction with each other; *i.e.*, the standards established for any one product are dependent upon

the requirements of use in association with other materials. This involves overlapping of committee work and demands systematic correlation of interlocking activities. R.A.H.

Application of colloid chemistry to study of clays. I. A. E. VICKERS. *Trans. Ceram. Soc.* [Eng.], **28** [2], 91–97 (1929).—This paper is a résumé of a portion of a larger dissertation dealing with both the chemical and geological aspects of the study of clays which was presented to the Univ. of London as part of its requirements for the degree of Master of Science. It represents an attempt to restate some of the problems which confront the student of soils and clays (and ceramics) in terms of colloid chemistry. A large number of references have been consulted in order to obtain information on the subject and the paper is largely of a bibliographical nature in consequence. The application of the methods of colloid chemistry to the study of clays and soils seems to be the most promising method of research in this field, and is that which at the present time is yielding the most useful results. R.F.S.

X-ray diffraction study of calcite-rhodochrosite series. PHILIP KRIEGER. *Amer. Mineralogist*, **15** [1], 23–29 (1930).—Data obtained by a study of the indices of refraction, specific gravities, and X-ray diffraction patterns of manganocalcite show a uniform variation within experimental limits depending upon the chemical composition. A study of five specimens of manganocalcite shows a definite relationship between the per cent of manganese carbonate and the physical or structural and optical properties. The relation of the manganese carbonate content to the specific gravity is indicated by a gradual rise in value as the calcium carbonate is replaced by manganese carbonate until the composition of rhodochrosite is reached. The indices of refraction show an increase in both ϵ and ω as the per cent of manganese carbonate increases, approaching those of rhodochrosite as a limit. The first line of the diffraction patterns varies from 3.075 Å in calcite to 2.850 Å in rhodochrosite. F.P.H.

Fullers' earth clays. O. ECKART. *Tonind.-Ztg.*, **54** [1], 17 (1930); for abstract see *Ceram. Abs.*, **9** [2], 130 (1930). M.V.K.

Status of phosphate industry of Western U. S. FRANK COLE. *Mining and Met.*, **11** [278], 104–105 (1930). F.P.H.

Geophysical investigations at Caribou, Colo. C. A. HEILAND, CHARLES W. HENDERSON, AND J. A. MALKOVSKY. Bur. Mines, *Tech. Paper*, No. 439, 45 pp. (1929). R.A.H.

Bentonite, a mineral of many possibilities. ANON. *Mining Jour.*, **164** [4877], 102 (1929).—Bentonite is capable of absorbing more than ten times its volume of water. Purified ground-alkali bentonite should make good filters, binders, or plastics in the manufacture of numerous industrial materials, due to its general characteristics, such as extreme state of subdivision, property of remaining in suspension, plasticity, and absorbent power. E.C.C.

Occurrence of beryllium in zinc deposits of Franklin, N. J. CHARLES PALACHE AND L. H. BAUER. *Amer. Mineralogist*, **15** [1], 30–33 (1930); see also *Ceram. Abs.*, **8** [3], 218 (1929). F.P.H.

Canada's 1929 mineral production. S. J. COOK. *Can. Chem. Met.*, **14** [1], 38 (1930).—Reflecting the growth in general construction, the output of cement at 12,277,072 bbls., valued at $19,595,000, showed gains of 11.4% in quantity and 17% in value over the output of 11,023,928 bbls. shown in 1928 at a value of $16,739,163. Clay products at $13,055,000 gained 5.4% over the total of $12,381,718 for the preceding year. Stone, sand, and gravel in 1929 were valued at $17,700,000, or 9.9% above the value of $16,081,732 for 1928. Gypsum production showed a slight improvement during the year, the tonnage being 1,256,000 T. compared with 1,246,368 T. in 1928. Value in 1929 was $3,666,000, or about 2% under the 1928 total. Cobalt

(of which Canada produces from 50 to 55% of the world's supply) was produced steadily throughout the year, the value of it and platinum metals totaling $2,248,000. E.J.V.

Cryolite in Germany. F. W. ALLPORT. *World Trade News; Glass Ind.*, **11** [2], 38 (1930).—Artificial cryolite (sodium aluminum fluoride) is produced on a substantial scale in Germany. The natural product is imported to the extent of about 3000 metric tons annually. A principal use for this production is as a solvent for aluminum oxide in the manufacture of aluminum. E.J.V.

Soda content of feldspar. W. EITEL. *Ber. deut. keram. Ges.*, **10** [11], 522–28 (1929).—E. discusses the Na_2O content of feldspars in the light of the recent X-ray work of Hadding and T. Barth on the crystal structure of the various feldspars. Hypothetical phase diagrams covering the systems microcline-albite and orthoclase-microcline-albite are suggested. F.P.H.

Pink mineral similar to kaolin. SATOYASU JIMORI AND JUSS YOSHIMURA. *Sci. Papers Inst. Phys. Chem. Research* [Tokyo], 224 (1929); *Chem.-Ztg.*, No. 61, p. 595 (1929); *Tonind.-Ztg.*, **53** [99], 1748 (1929).—This mineral is called takizolite and its composition is $2Al_2O_3 \cdot 7SiO_2 \cdot 7H_2O$. It contains a remarkable quantity of rare metals, among which is ruthenium. M.V.K.

BOOKS

Ore Deposits of Magmatic Origin. PAUL NIGGLI. Translated by H. C. Boydell. 93 pp. 11 figs. Thomas Murby and Co., London. D. Van Nostrand Co., New York, 1929. Reviewed in *Amer. Mineralogist*, **15** [1], 43 (1930).—This book is an adaptation of a series of lectures presented at the Swiss Federal Technical University of Zurich in 1923 to 1924 and published as Vol. 1. of Niggli's "Abhandlungen zur praktische Geologie und Bergwirtschaftslehre." The translation by Dr. Boydell has been revised and supplemented by Dr. Niggli and R. L. Parker. In this brief treatise N. attempts to develop a logical and consistent classification of ore deposits of magmatic origin. Such a classification he believes must hold good not only for ore deposits but also for igneous rocks and vice versa. N. points out that a systematic classification of igneous rock may be founded on any one of the three following bases: (1) physical and geological conditions prevailing at the place of formation, (2) chemical and(or) mineralogical composition, and (3) provincial relationships. These points are discussed as to their application to ore deposits. The result is one classification combining (1) and (2) and a second classification combining (1) and (3). F.P.H.

Ceramic Materials of Indiana. W. H. LOGAN. Indiana State Conservation Department. Reviewed in *Clay-Worker*, **93** [2], 140 (1930).—Indiana already produces a large amount of ceramic ware, and is the seventh state in rank in ceramic production in the U.S. The quantity and quality of the raw materials, and the abundance of low-cost fuel in Indiana justify a much larger production of these products. The shales and clays of the state may be divided into four general classes, depending on their origin. The physical properties, chemical composition, uses, and purposes of each of these classes of raw materials are discussed, and the chemical analysis of a number of representative samples is given. The pamphlet also includes a geological map of Indiana, and a map showing the distribution of shales and clays in the state. E.J.V.

Applied Geophysics in Search for Minerals. A. E. ERIE AND D. A. KEYS. Cambridge University Press. Price 12s 6d, net. Reviewed in *Engineering*, **129** [3339], 39 (1930).—Various methods used in prospecting minerals are taken up which include magnetic, gravitational, seismic, and electrical methods. A considerable portion of the volume is devoted to the latter method which is regarded the more promising, as the experimental equipment required is simple and easily obtainable. A.A.

Chemistry and Physics

Simple control stop-cock for gas analysis apparatus. MARTIN SHEPARD. Bur. Stand., *Jour. Research*, **4** [1], 23–26 (1930).—This paper describes a simple control stop-cock for gas analysis apparatus. The control permits pressure balance to be obtained easily, quickly, and with high accuracy. Diffusion errors are eliminated without danger of emptying the manometer. The accidental surge of pipette reagents into the train is prevented. Difficult combustions of heavy hydrocarbons may be made without the deposition of carbon. The technique of operation and actual means of construction are described. R.A.H.

Comparative X-ray examinations of magnesium-silicates. B. GOSSNER AND F. MUSSGNUG. *Neues Jahrb. Mineral.* [Additional volume], **58**, 213–52 (1929); *Tonind.-Ztg.*, **53** [104], 1821 (1929). M.V.K.

Explanation of silicic-hydrates by means of ammonia extraction procedure. WILH. BILTS AND ERICH RAHLFS. *Z. anorg. allgem. Chem.*, 273–91 (1929); *Tonind.-Ztg.*, **53** [104], 1821 (1929). M.V.K.

Studies on calcium-magnesium separation by oxalate method. II. Z. HERMANN. *Z. anorg. allgem. Chem.*, **184** [1], 289–92 (1929).—When calcium is precipitated by the oxalate method in the presence of magnesium there is always some contamination. This was thought to be due to a solid solution formation. X-ray diagrams failed to show any solid solution and the contamination must, therefore, be considered as a surface adsorption phenomenon. X-ray diagrams showed two forms of the calcium oxalate monohydrate. One form is the precipitate from a hot and the other from a cold solution. For Part I see *Ceram. Abs.*, **8** [12], 920 (1929). L.T.B.

Method of quantitative crystal analysis by means of X-rays. A. ZWETSCH AND H. STUMPEN. *Ber. deut. keram. Ges.*, **10** [12], 561–67 (1929).—The principle of the method is briefly: the intensity of the Debye-lines from the substance under investigation in one chamber is compared with those from the same substance of 100% purity in a second chamber, the time of exposure of the photographic plate being the same in the two cases. F.P.H.

Rational analysis of refractory clays by sulphuric acid. HUBERT GREWE. *Ber. Chemikerausschuss*, No. 65; *Tonind.-Ztg.*, **53** [80], 1437 (1929); for abstract see *Ceram. Abs.*, **9** [1], 64 (1930). M.V.K.

Tests of Stokes' law for non-spherical particles. A. H. M. ANDREASEN. *Rock Prod.*, **33** [2], 82 (1930); see *Ceram. Abs.*, **9** [1], 66 (1930). W.W.M.

Application of sedimentation analyses and depolarization method to ceramic research. H. MÖHLE AND B. LANGE. *Ber. deut. keram. Ges.*, **10** [11], 529–44 (1929).—A comparison is made of the results obtained with the use of the Wiegner-Lorenz sedimentation method (*Z. angew. Chem.*, **46**, 1375 (1927)) for determining the particle-size distribution curves for clays with those obtained by the use of the depolorization method of B. Lange (*Z. physik. Chem.*, **132**, 1 (1928)). The sedimentation method is applicable to the study of particles ranging in size from 30μ to 3μ. The depolorization method is applicable to the range 3μ to the finest colloidal particle. Particle-size distribution curves obtained by the two methods are presented for a number of German clays. See also *Ceram. Abs.*, **7** [11], 749 (1928). F.P.H.

Effect of light on silver chloride in chemical analyses. G. E. F. LUNDELL AND J. I. HOFFMAN. Bur. Stand., *Jour. Research*, **4** [1], 109–14 (1930).—Experiments described in this paper show the direction and magnitude of the errors that may be expected in analytical work if silver chloride is not protected from light. Exposure to light during precipitation always causes positive errors if silver is in excess, and negative errors if hydrochloric acid is in excess. Exposure to dry precipitates has very little effect. The error, if any, is negative and becomes greater if the dried precipi-

tate is moistened before exposure or if the precipitate is exposed before drying. Exposure to light probably produces a mixture of metallic silver and silver chloride.
R.A.H.

Behavior of gas bubbles in capillary spaces. IONEL I. GARDESCU. *Mining and Met.*, **11** [278], 28 (1930).—The Jamin action is the resistance offered by detached gas and liquid bubbles confined to capillary tubes by a boundary condition which develops whenever the liquid does not wet the solid walls of the capillary. The resistance opposed by the bubbles is proportionate to the variation of the solid-surface-tension at the two extremities of each individual liquid bubble and is inversely proportionate to the radius of the capillary tube. For oil and sand the Jamin effect is small or even zero. The resistance p offered by a gas bubble when forced into a capillary opening is given by the equation: $p = 2S\left(\frac{1}{r_1} - \frac{1}{r_2}\right)$ in which S is the surface tension, r_1 the interporous opening through which the bubble is forced, and r_2 the maximum curvature of the distorted bubble, when the curvature at the other extremity of the bubble is r_1. To be forced through a capillary opening of 0.011 cm. diam., a gas bubble, present in a liquid medium of surface tension equal to 23, will require a pressure of from zero to 4000 dynes, depending on its size. The magnitude of resistance offered by gas bubbles forced through small openings so far exceeds any possible resistance caused by the Jamin effect that the latter phenomenon need scarcely be considered in dealing with the movement of oil and gas through their natural reservoir rocks. F.P.H.

Fundamental definitions of rheology. EUGENE C. BINGHAM. *Proc. A.S.T.M.*, **29** [II], 909–23 (1929).—Two hundred and fifty years have passed since Hooke's work on elastic deformation and 250 years since the work of Newton on the flow of fluids, yet the knowledge of the deformation and flow of matter in its various states scarcely yet constitutes a science. To avoid lengthy circumlocutions in the future this branch of knowledge may be referred to as rheology. Elasticity is confused with plasticity by referring to plastic flow as "imperfection of elasticity." The use of the simple laws of fluid flow when dealing with the flow of solids involves the gratuitous assumption that all types of plastic flow are identical with the linear type of fluid flow. This adds to the confusion. During recent years efforts have been made to distinguish some of the types of plastic flow and to discover the laws governing them, but with this work exact definitions become necessary and these in turn have a bearing upon our technical definitions, specifications, and methods of testing and measurement. This paper suggests in a tentative manner some of the definitions which are involved. They have already been criticized by a large number of scientists and are offered at this time to stimulate still further criticism. After so many years there naturally exists a great diversity of opinion, but with more adequate knowledge there exists the possibility of clarification of our point of view, if the problems can be approached patiently.
R.A.H.

Reactions of titanium sesquioxide with oxides of iron. F. HALLA. *Z. anorg. allgem. Chem.*, **184** [4], 421–25 (1929).—X-ray crystal structure studies showed two forms of Ti_2O_3; one was obtained from titanic acid anhydride and the other from titanic acid hydrate. Both of these forms react with ferric and ferrous oxide to form $FeO{\cdot}Ti_2O_3$, which has a unit cell of eight molecules. The calculated density of this compound is 4.68; the length of the edge of a unit cell is $a = 8.47 + 0.02$Å.
L.T.B.

Emanation method as means of making physical-chemical studies. OTTO HAHN. *Naturwissenschaften*, **17** [18], 295–96 (1929).—By this method a radio-active compound is intimately mixed with the material to be studied. By measuring the amount of emanation from the mixture some idea of the nature of the unknown material may be

obtained. Thus the amount of emanation from a glass is less than that from a crystalline material. The method may be used to study particle size, aging, coagulation or swelling of gels as well as absolute changes in surface area. H. has used the method in studying the structure of glasses and crystalline materials, especially the zeolites. Recently the method has been applied to study the changes in viscosity on heating a glass and to study the relation of the softening temperature of a material to its melting point. L.T.B.

Quantitative determination of sulphates in fluorides. H. GINSBERG AND G. HOLDER. *Z. angew. Chem.*, **42** [12], 314–17 (1929).—Five methods are outlined for the determination of sulphates in aluminum fluorides, especially cryolite. L.T.B.

Determination of temperature of end of solidification of solid solutions. RUDOLPH RUER AND KARL KREMERS. *Z. anorg. allgem. Chem.*, **183** [3], 223–24 (1929).—The authors found that the melting breaks on heating curves are much sharper and better defined than the crystallization breaks on cooling and therefore recommend heating curves for determining melting relations. L.T.B.

Double carbonates of alkalis and alkaline earths. W. EITEL AND W. SKALIKS. *Z. anorg. allgem. Chem.*, **183** [3], 263–86 (1929).—The following double carbonates were made in a bomb calorimeter at high pressures: $Na_2Ca(CO_3)_2$, $Na_2Mg(CO_3)_2$, $K_2Ca(CO_3)_2$, $K_2Mg(CO_3)_2$, $NaLiCO_3$, $KLiCO_3$. All are optically negative and belong to the hexagonal or trigonal system. The salt, $K_2Mg(CO_3)_2$, may be undercooled when a liquid and obtained as a glass readily. X-ray examinations were made of all materials. L.T.B.

Thermal revision. I. W. A. ROTH. *Z. phys. Chem.*, **144** [3], 253–58 (1929).—In view of modern developments in methods of measurement it is highly necessary to have exact measurements in inorganic thermo-chemistry. Therefore the heat of formation of SiO_2 and of Al_2O_3 was re-measured and found to be 204.0 ± 2.1 Cal. and 380.8 ± 0.4 Cal., respectively, at constant pressure. These values are higher than those reported formerly. L.T.B.

Quantitative chemical analysis by means of X-ray emission spectra. H. SCHREIBER. *Z. Physik.*, **58** [9], 619–50 (1929).—A new fluorescence method was developed by which it is possible to analyze easily volatile materials and solutions. The maximum error in the determination of the amount of an element is 7%. L.T.B.

Value of liaison in refractory research. A. J. DALE. *Refrac. Jour.*, **5** [52], 132–33 (1930).—Two distinct schools of research thought exist. One, disinterested industrially, favors a ceaseless investigation of fundamentals, advocates a continued prying into the very structure of the clay particle itself, and into its behavior in such various chemical and physical circumstances as may be satisfactorily arranged in the laboratory. On the other hand, the industrial school of thought inclines to the opinion that the difficulties associated with the production or use of refractory materials should be tackled as definite problems, the solution of which will result in the improvement of a process, in the evolution of some novel method of treatment or manufacture. With reference to the technique of kiln firing, academic research attempts to elucidate the reactions involved in the burning of fuel rather than to suggest the type of grate or kiln design. Industrial research has necessarily an economic bias. The identification of sillimanite or mullite in the microstructure of hard-fired porcelain will suggest this compound to be a refractory of the first class. E.P.R.

Specific heat and temperature. ANON. *Refrac. Jour.*, **5** [52], 149 (1930).—For a long time it was thought that the specific heat of each material was the same at all temperatures, but careful experiments have shown that this is not the case. Nernst has shown that, theoretically, the specific heat must increase with the temperature. Recently Miehr, Immke, and Kratzert have made a further series of determinations of the specific heats of various refractory materials and have found that the specific

heat increases with the temperature. Their results are shown in the accompanying table.

	Specific heat in calories per gram								
	600	700	800	900	1000	1100	1200	1300	1400°C
Silica	0.248	0.254	0.259	0.262	0.266	0.270	0.273	0.275	0.278
Charomite brick		.206	.211	.214	.217	.220	.222	.224	.226
Warnsdorf kaolin		.252	.255	.259	.263	.266	.268	.271	.273
Corundum with 2% bond			.264	.268	.271	.275	.280	.283	.285
Carborundum with 2% bond					.264	.265	.266	.270	.290
Carborundum with 10% bond		.252	.255	.259	.263	.266	.268	.271	.273
Quartz-glass			.277	.263	.263		.267		.267

They have also found that there is a close relationship between the specific heat and the coefficient of expansion, the quotient obtained by dividing the specific heat by the percentage linear expansion, being almost constant at all temperatures for any given material, but tending to increase very slightly with the temperature. See also *Ceram. Abs.*, **7** [8], 545 (1928). E.P.R.

Action of fluorine on inorganic and organic compounds. FR. FICHTER. *Jour. Soc. Chem. Ind.*, **48T**, 354–57 (1929).—Elementary fluorine is shown to be a strongly oxidizing agent. H.H.S.

X-ray investigation of effect of heat on alumina hydrate $Al_2O_3 \cdot 3H_2O$. H. P. ROOKSBY. *Ber. deut. keram. Ges.*, **10** [12], 577–78 (1929); *Trans. Ceram. Soc.* [Eng.], **28** [10], 399–404 (1929). F.P.H.

New reaction for testing minerals. H. LEITMEIER. *Stahl Eisen*, **49** [47], 1706 (1929); *Tonind.-Ztg.*, **54** [1], 17 (1930).—A new method for determining dolomite, magnesite, and calcite is given. A particle of the test piece was heated with a solution of a given dye (not named) which colored magnesite but not the dolomite or calcite. Other color reactions permitted the identification of traces of magnesium as well as phosphoric and silicic acids. The determination of silicic acid is so sharp that even traces which have been dissolved from the glass pots in heating, can be easily recognized. M.V.K.

Constitution of Rinmann green, Thènard blue, and other colored solid derivatives of cobalt oxide. G. NATTA AND L. PASSERINI. *Gazz. chim. ital.*, **59**, 620–42 (1929).—A survey of the literature shows contradictory hypotheses regarding the nature of the colors and the chemical composition of binary systems of bivalent Co and other metallic oxides. X-ray analysis was chosen as a means of obtaining decisive information on the constitution of these various complexes. The first products, which were examined by X-ray to determine the valency of Co, were prepared by calcining mixtures of $Co(NO_3)_2$ and $Zn(NO_3)_2$ in air at 800 to 1000°. They were dark green, contained a considerable quantity of tervalent Co, the latter diminishing with increase in the temperature of calcination. They consisted of mixtures of crystals of $ZnCo_2O_4$ (cubic with a = 8.06 A. U.), with other crystals having a hexagonal lattice practically identical with that of ZnO (a = 3.24 A.U.). The products which were richest in Co (containing about 30 to 40%) and which were obtained after long calcination above 1000° showed the lines of CoO. The products obtained by calcination *in vacuo* of solid solutions of $Co(OH)_2$ and $Zn(OH)_2$ or of basic Co and Zn carbonates contained all their Co in the bivalent state. Those containing less than 30% CoO showed a beautiful malachite green shade and were composed of solid hexagonal solutions of CoO in the lattice of ZnO. Those containing over 70% CoO were rose colored and were composed of solid cubic solutions of ZnO in the lattice of CoO. A green solid solution containing 28.9% CoO had a hexagonal elementary cell with a = 3.220 ± 0.005 A.U. and a height

of 5.18 A.U. A rose-colored solid solution containing 72.87% CoO had a cubic elementary cell with $a = 4.225 \pm 0.005$ A.U. The products containing an intermediate quantity of CoO were composed of mixtures of crystals of which 1 part had the same lattice constants as solid solutions containing 28% CoO and the other part those of solid solutions containing 72% CoO. The color of Rinmann green depends upon hexagonal solid solutions. The presence of tervalent Co in the form of $ZnCo_2O_4$ makes the green color darker. $ZnCo_2O_4$ dissociates above 900 to 1000° into O and the oxides of the bivalent metals and the lower the pressure the greater this dissociation. The rose-colored products obtained by calcination at high temperatures of mixtures of CoO and MgO are composed exclusively of cubic solid solutions of CoO and MgO; they contain no tervalent Co, provided that superficial oxidation is prevented during cooling. $MgCo_2O_4$, obtained only at relatively low temperatures, is less stable than $ZnCo_2O_4$, and it dissociates on gentle calcination of cubic solid solutions of MgO and CoO. CoO and MgO are soluble in the solid state in all proportions, and the lattice constants of the solid solutions conform to the law of Végard. The solid solutions of 50% CoO-50% MgO have an elementary cell with $a = 4.220 \pm 0.005$ A.U. Thènard blue owes its color to cubic $CoAl_2O_4$, with the structure of spinels and an elementary cell with $a = 8.06$ A.U. The technical blue products do not contain tervalent Co, and X-ray analysis shows that they are composed of mixtures of 2 substances, 1 of which has the lattice of corundum, and the other that of $CoAl_2O$. The products containing more than 50% CoO contain part of the Co as tervalent Co, have darker colors, a lattice similar to that of $CoAl_2O_4$, and are probably composed of solid solutions of the 2 isomorphic compounds $CoAl_2O_4$ and $CoCo_2O_4$, having practically identical lattice dimensions. The green products obtained by calcination of mixtures of SnO_2 and cobaltous compounds, owe their colors to Co_2SnO_4 which is cubic and which has the structure of spinels, with an elementary cell with $a = 8.61$ A.U. The technical products are composed of physical mixtures of 2 substances, 1 having the lattice of cassiterite, the other that of Co_2SnO_4. By strong calcination of $CoSnO_3$, a mixture of Co_2SnO_4 and SnO_2 is obtained. (*C.A.*)

Determination of pore size in heteroporous partitions, such as an egg shell. A. V. Dumanskiĭ and E. P. Strukova. *Jour. Russ. Phys.-Chem. Soc.*, **61**, 381–91 (1929).—Torricelli's equation $U = K\sqrt{P-p}$ can be applied to the case where air is forced through a porous wall immersed in water; or $V = K\pi r^2 n\sqrt{P-p}$ (1), V being the volume of air which transpires in unit time, r the radius of the pores, n their number, P air pressure at which the measurement is made, and p pressure at which the transpiration velocity approaches 0. Hence, if r is known from $r/p = 2\sigma$ (2), the measurement of V and K suffices to calculate n. The value of K was determined by forcing air through a round puncture in an Al plate at $P = 7$ to 55 cm. For $r = 0.11$ mm., K equaled 0.92, and for $r = 0.267$ mm., 1.02. In a "heteroporous" membrane like an egg shell the diameter of the pores varies. The number of pores of each size can be determined from velocities of air flow at different pressures. Let p_1 be the pressure at which air bubbles just begin to detach; from equation 2 one obtains r_1 = the radius of the largest pores. The pressure is raised to P_1 and air begins to escape with the velocity $V_1 = KS_1\sqrt{P_1-p_1}$, where S_1 is the total surface area of the pores of radius r_1. A still higher pressure P_2 will force air through the pores of radius $r_2 = 2\sigma/P_1$, so that the total transpiration velocity will be $V_2 + V_2' = S_1K\sqrt{P_2-p_1} + S_2K\sqrt{P_2-P_1}$. The terms thus evaluated are $S_1K + S_2K + S_nK = SK$, S being the total surface area of all the pores. The surface of each group of pores is then expressed in % of S and plotted against r as the abscissa. Another "distribution function" is obtained by dividing the terms in the above equation by πr_1^2, πr_2^2, etc., respectively, and setting the mm. equal to $K'N$, where N' is the total number of pores: $K'n_1 + K'n_2 + K'n_n = K'N$. The values of these terms, expressed in % of $K'N$, are also plotted against r. The

apparatus consisted of a compressed-air tank connected to a manometer and a reservoir communicating by means of a stop-cock with the porous vessel immersed in water. The escaping air was collected in a eudiometer, and its volume measured in a gas burette. Egg shells stained with methylene blue and viewed through a microscope contained pores of 0.006 to 0.016 mm. in diam. To determine the number of pores of each size, the inner vesicle was dissolved in hot 10% NaOH, and the shell cemented to the connecting tube. The pressure varied between 20 and 70 mm. Hg. $KS/\Delta d$ was plotted against p, d being the diameter of the pores. For the purposes of comparison, the porosity was defined as ΣKS; thus the 2 egg shells studied had the porosity of 14.3 and 26.1, respectively. The distribution curve in both the cases showed a maximum at about 5μ. (*C.A.*)

Estimation of silica in tissues. E. J. KING. *Jour. Ind. Hyg.*, **11**, 211 (1929).—A micromethod for estimation of SiO_2 is based on the production of yellow silicomolybdic acid. H.H.S.

Soluble salts as flotation reagents. NEVIN HAL MCKAY. *Eng. Mining Jour.*, **128** [24], 920–21 (1929).—Ferrous sulphate is used in chalcopyrite-pyrite separations. E.C.C.

Electrokinetic potential and its relation to rate of coagulation of colloids. BHUPENDRA NATH GHOSH. *Jour. Chem. Soc.* [London], p. 2693 (1929). E.C.C.

Duration of metastable states. J. M. ANDERSON. *Can. Jour. Research*, **2**, 13 (1930).—The half-value time of absorption from metastable electronic atomic states is calculated on the hypothesis that the whole decay is due to collision phenomena. Definite assumptions which include the atomic energy level scheme, are made as to the efficiency of collisions and the interaction of two metastable states in these processes. The assumption adopted as the only one producing an approximation to experimental facts shows that the probability of an exchange is dependent on the absolute value of the energy difference between the states concerned. The results calculated from the final formula, for helium, neon, and argon at normal and very low temperatures depend on one arbitrary constant, which is the same for all states and gases considered, and show fair agreement with any experimental values so far published. An estimate is made of the energy tolerance of a quanta transition. W.L.

Determination of calcium oxide in quicklime. ANON. *Chem. Weekblad*, **26**, 511 (1929); *Rock Prod.*, **33** [2], 82 (1930).—Direct titration gives very low results, owing to the slowness with which the oxide dissolves. The phenol and ammonia methods also give low results, though the error is less; the ammonia distillation method is still more accurate, but gives low results. Boiling with excess standard acid and back-titration, combined with carbonate determination, gives quite accurate results. W.W.M.

Cohesion and atomic structure. SAUL DUSHMAN. *Proc. A.S.T.M.*, **29** [II], 7–66 (1929).—There exists a relationship between at least four cohesional properties of the elements and electronic configuration of the atoms. The crystal structure of pure metals also shows a similar connection with electronic arrangement and cohesional forces. While a theory of cohesion in solids based upon atomic structure has not yet been formulated, it is possible to calculate the magnitude of cohesive forces by introducing plausible assumptions regarding the laws of attraction and repulsion between atoms. As shown by Grüneisen for the case of pure metals and by Born for ionic lattices (such as rock salt) there must exist definite relation between the theoretical cohesive force between atoms and such experimentally observed values as density, latent heat of evaporation, and coefficients of expansion and compressibility. The cohesive forces calculated on the basis of this theory are found to be from 10 to one hundred times greater than the rupture strengths actually observed. In explanation of this discrepancy

Griffits and Smekal suggested the presence of fine cracks, crevices, or inhomogeneities in the crystal structure. The effect of temperature on rupture strength is discussed at length. Analogy with other reactions, both chemical and physical, whose rates change with temperature in the same manner, suggests that from the temperature coefficient of the rupture strength, it should be possible to calculate the energy required to cause relative translational motion of atoms or grains such as occurs in plastic flow of solids. Similarly from the rate of grain growth, rate of diffusion, electrolytic conductivity of salts, viscosity of glass, rate of flow of metals, each of which changes rapidly with temperature, it is possible to calculate the energy involved in the reaction.

R.A.H.

BOOKS

Keramische Materialkunde. G. JAKÓ. Revised and with an Appendix by R. JÄGER. Pp. viii + 153. T. Steinkopff, Dresden, 1928. Paper, 7.50 Rm.; cloth, 9 Rm. There is no volume devoted exclusively to the description and properties of the chief minerals and other substances used in the ceramic industries, and insofar as this volume contains ample and accurate information on such substances, it fills a gap in ceramic literature. It does not contain, nor is it intended to do so, any new information, but is a handy compilation of much of the information needed by those in a position of executive authority in the pottery and allied industries. It would be much more useful if it contained more information of this nature, especially that which is not readily accessible to the working ceramist. The recognized text books on ceramics contain most of the information in more scattered form, and even more can be found by searching through the journals and also books on chemistry and mineralogy. It is, however, convenient to have what is most likely to be required within the compass of 150 pages, especially as many of the sections contain references to the literature of the subject. The authors have ignored, almost completely, the large amount of information in English and American books and journals, and this is to be regretted, as it deprives the book of much of its value. Highly important subjects, such as the inversion of quartz, are dealt with superficially. The formation of mullite on heating clay is not mentioned, J. being evidently under the impression that sillimanite is produced. The most disappointing section is that on clays which occupies one seventh of the volume, yet is sketchily written. A section on the general properties of clays is equally slight and, as is not unusual with German writers, the term "binding power" is wrongly regarded as synonymous with "plasticity." No definition is given of plasticity and its cause is stated to be unknown. The section on fuels is good, but might with advantage be much fuller. A chapter on calculating the costs of various body-mixtures may be useful to some readers, as may also a series of tables for facilitating calculations of molecular formulas, etc. There is a good index, which also includes the formulas and molecular weights of most of the substances mentioned. While chiefly of use to students at various German-speaking ceramic schools, this volume should also be of value to some English ceramists, though as previously stated, the latter can find most, if not all, the information in works in their own language. (*B.C.A.*)

Industrial Heat Transfer. A. SCHACK. *Glass Ind.*, **11** [2], 44 (1930); for abstract see *Ceram. Abs.*, **9** [3], 240 (1930). E.J.V.

History of Science. W. C. D. DAMPIER. Cambridge Univ. Press, Cambridge, 1929. Price 18s.—An admirably planned volume in which D. takes all science for his province. H.H.S.

Effects of Moisture on Chemical and Physical Changes. J. W. SMITH. Pp. 247. Longmans, Green & Co., London, 1929. Price 15s. H.H.S.

Diamond Alkali Handbook. DIAMOND ALKALI CO. 2nd ed. 72 pp. *Glass Ind.*, **11** [2], 49 (1930); *Amer. Glass Rev.*, **49** [16], 16 (1930).—A brief description of the

ammonia-soda process and the chemical reactions obtained is given. A table for use in converting from one to the other of the systems used to express the alkalinity of soda ash and caustic soda and other tables including one showing the gross and net shipping weights and storage space required for materials shipped in bags, barrels, kegs, and drums, are also given. The company's products include in addition to soda ash, caustic soda, bicarbonate of soda, and liquid chlorine. Many uses of these products are charted. E.J.V.

PATENTS

Ceramic mass. JAMES M. LAMBIE AND DONALD W. ROSS. U. S. 1,745,102, Jan. 28, 1930. A ceramic casting slip containing ammonium radical and a basic compound of a metal.

Method of making zeolite. SVEIN DAHL-RODE. U. S. 1,745,337, Jan. 28, 1930. In producing base-exchange substances, the method which comprises effecting reaction between iron furnace slag and caustic soda, drying the reaction product and subdividing it into granules, washing the granules, thereafter subjecting the granules to acid, thereafter washing the granules, and thereafter subjecting the granules to a salt solution.

Expansion of plaster of Paris. JOHN D. WIGGIN. U. S. 1,746,691, Feb. 11, 1930. (1) Method of indicating the expansion or contraction of plaster of Paris, etc., which comprises molding it against a curved molding surface, removing the surface before the substance has set, allowing it to set and change its dimensions, and then noting the degree of change in comparison with the molding surface. (2) An instrument for indicating the expansion or contraction of plaster of Paris or similar substances comprising a plaster retaining device having a base and upstanding arms and a movable molding member to fit between and engage the arms and presenting a curved molding surface.

Process of treating mixtures of alkali stannates, arsenates, and antimonates. ARTHUR E. HALL. U. S. 1,747,709, Feb. 18, 1930. The process of separating alkali stannates, arsenates, and antimonates which comprises dissolving the arsenates in a hot caustic solution of alkali chloride of such concentration that the alkali stannates and antimonates are substantially insoluble therein, separating the solution from the undissolved alkali antimonates and stannates, dissolving the alkali stannates in hot water and separating the alkali stannate solution from the undissolved alkali antimonates and treating the alkali stannate solution with a suitable reagent to precipitate lead, copper, antimony, tellurium, and other deleterious impurities.

Titanium oxide. MAURICE JACMART, LUCIEN PELLEREAU, AND GUENHAIL LE BRIS. Fr. 663,068, Oct. 23, 1928. TiO_2 free from Fe is obtained by treating the ore with Na_2CO_3 at 1000° in the presence of a reducing agent and a flux, washing the product and treating with H_2SO_4. The solution of $TiSO_4$ is reduced by electrolysis with Pb anodes, hydrolyzed in the presence of SO_2 or $NaHSO_3$, and the product is washed and calcined at 900 to 1000°. (*C.A.*)

General

Spend that you may gain. EDITORIAL. *Glass Ind.*, **11** [2], 36 (1930); reprinted from *Bull. Amer. Ceram. Soc.*, **9** [1], 3–4 (1930); see also *Ceram. Abs.*, **9** [3], 236 (1930). E.J.V.

General Index of the Journal of the German Ceramic Society 1920 to 1929 inclusive. Edited by LISOLOTTE MAUVE. Published by Deutschen Keramischen Gesellschaft. E. V. Berlin. F.P.H.

Reliability of fusible tin boiler plugs in service. JOHN R. FREEMAN, JR., J. A.

SCHERRER AND S. J. ROSENBERG. Bur. Stand., *Jour. Research*, **4** [1], 1–22 (1930).—It has been found that under certain conditions fusible plugs would not operate due to the formation of a refractory oxide replacing the tin in the fire end of the plug. The apparatus is described in which plugs may be tested under simulated service conditions. R.A.H.

Heat-insulating materials. ANON. Bur. Stand., *Tech. News Bull.*, No. 153, p. 2 (1930).—Within the past few years there has been great activity in the fields of thermal insulation, particularly for dwellings, and a large number of materials have been utilized in the manufacture of insulating products of various kinds. Anticipating the need for additional data the Bureau is conducting a study of the insulating properties of various fibrous materials which may prove suitable for insulating purposes. Tests have been made on jute, cotton, flax, wood fiber, bagasse, corn stalk fibers, moss, excelsior, wood shavings, etc. It has been found that each fiber has an optimum density at which the thermal conductivity is a minimum or the insulation value is a maximum. R.A.H.

Silicon steel for constructions. ANON. Invest. Inst. of Union of Stahlw. *Tonind.-Ztg.*, **54** [3], 49 (1930).—The authors have conclusively established the superiority of silicon steel over ingot steel for heavy construction, demonstrating its greater economy in weight combined with higher tensile strength. It cannot, however, compete at present with ingot steel because of the difficulties of its manufacture. Tables and diagrams give the results of the experiments. M.V.K.

Diesel engine. ANON. *Mining Jour.*, **166** [4899], 24 (1929). E.C.C.

Report of Special Committee on Reference Laboratory. ANON. *Proc. A.S.T.M.*, **29** [1], 262–65 (1929).—The following outline of the work to be done and methods to be followed is presented. A fellowship should be established at the U. S. Bur. of Standards, to be known as "Cement Reference Laboratory for Standard Cement Testing." Under this fellowship a laboratory should be instituted, with apparatus and personnel capable of making tests of Portland cement in strict conformance with the standard specifications and tests of the A.S.T.M. The work at first will be physical. This laboratory staff is to be prepared to instruct on established methods of making tests, and proper methods for maintaining testing equipment, also to calibrate testing equipment submitted by purchasers or by manufacturers of such equipment. This laboratory staff, at the request of the directing head of a cement testing laboratory, is to make a report upon the adequacy and accuracy of its apparatus to make cement tests to conform with the standard specifications. Suitable certificates covering the apparatus only will be issued to laboratories entitled to them. The report enlarges on the duties of this laboratory. R.A.H.

Modern mining explosives. WILLIAM CULLEN. *Mining Jour.*, **167** [4916], 897–98; [4917], 914–15; [4918], 931–32 (1929).—A thorough technical discussion of explosives with regard to their uses and action. E.C.C.

Heat losses from plant surfaces. R. M. COLLES. *Pottery Gaz.*, **55** [632], 263 (1930).—Heat losses from all surfaces are the result of two phenomena, convection and radiation. The convective effect, which manifested itself in all types of atmospheres, was augmented by the rate of movement of the fluid surrounding the object which was dissipating the heat. This augmentation was of a high order when winds played upon the object; so much so, that one of the results of the work reported showed that if the body dissipating heat were surrounded by an air space, from which drafts were precluded, the heat loss from the surface was considerably reduced. It was suggested as advisable in certain instances, in preference to using the more generally accepted insulating materials, to surround the object by a shield placed a few inches distant from the surface. In this way the comparatively stationary air space would prevent

high convective losses, and thus cut down the total heat loss from the surface. The work described definitely emphasized (1) the marked effect of convective currents, such as winds, in increasing heat losses from surfaces, and (2) the influence of certain paints in augmenting or reducing those heat losses. It was found that aluminium paint does not reduce the heat losses in the manner which some experimenters have claimed that it does. Any paint would, to some extent, act as an insulating layer and reduce the surface temperature slightly. E.J.V.

Oil engines result in cheaper power. ANON. *Brick Clay Rec.*, **76** [2], 124 (1930).—Oil engines are finding greater use in the clay products industry as each new plant is erected. Two plants of recent construction, the Alton Brick Co., and the Missouri Fire Brick Co., have installed engines as power providers because their service has been found to be cheaper than purchased power in each individual instance. A description of the installations of Diesel engines in each of the plants is given. E.J.V.

Generation of power. ANON. *Mining Jour.*, **166** [4899], 20 (1929). E.C.C.

Effect of large boilers at high capacities. FRANK S. CLARK. *Gas Age-Rec.*, **64** [25], 904–908 (1929).—C. treats various factors that enter into the design of boiler plants, their effect on investment costs and on operating characteristics. The development of the boiler plant is traced from a number of small units operated at moderate capacities to the present plant of a few large units run at high rate of evaporation. The governing factors in investment costs for a given condition are the size of the unit and output obtainable, the former depending on the ability to manufacture, and the latter on the fuel that can be burned in the furnace and the ability of the unit to absorb the heat. The proportioning of heat-absorbing surfaces between boiler, economizer, and air preheater to get the most economic result at minimum cost is discussed. F.P.H.

Engineering education, a layman's view. JAMES ROWLAND ANGELL. *Mech. Eng.*, **52** [1], 1–2 (1930). E.A.H.

Chemistry in ceramic industry. L. P. COLLIN. *Can. Chem. Met.*, **14** [1], 33 (1930).—A review of the situation is presented. The struggle from the position of the industry as an Art to the present, when large-scale production under chemical control is the rule, is traced. The chemistry of the industry is complex, because the materials used are largely members of the silicate series, and the combinations possible are many. Physical and colloid chemistry play a large part in the scientific work required. E.J.V.

Industrial power-factor problems solved by scale. ANON. *Glass Ind.*, **11** [2], 39–40 (1930).—The General Electric Co. has announced a new system of solving power-factor problems by a graphic method involving simple computations only. It consists of laying down to scale the known factors and then scaling the unknowns. Industrial power-factor problems can be solved by scale without resorting to degrees or functions of angles, squares or square roots, "kw." or "kv-a." All that is needed is a scale, pencil, and paper. A few typical problems are worked to illustrate the principles of this system. E.J.V.

Replacing of equipment. P. B. BUCKY. *Mining and Met.*, **11** [278], 99–101 (1930).—In this day of steady progress in the mining industry, especially along mechanical lines, the question of whether to discard present equipment for that of a new type often engages the minds of many officials of mining companies. The reason for the replacement of present equipment may be summed up as follows: (1) because of increased safety, (2) because of legal regulations, and (3) because of increased profits. Accurate data with reference to costs and returns on each unit in a mine are essential, and the more mechanized they are the more essential they become. Operation control and the cost sheet should go hand-in-hand. B. gives means of determining (1) the desirability of replacing present equipment and hence its corollary: (*a*) the desira-

bility of keeping present equipment; (2) the future date at which it will be desirable to replace present equipment. F.P.H.

Standardization of dimensions of keystones. LUDWIG GRÜTER. *Tonind.-Ztg.*, **53** [101], 1769–73 (1929).—To supplement the standardizations proposed by Ackermann (see *Ceram. Abs.*, **6** [10], 449 (1927)) for keystones in arches, G. undertook to standardize the angle of the keystone, model D of DIN 1081. From this the standardization of the angle of the arch and the perpendicular are established. The standardizing of all arch angles which are multiples of 4° 30′ was sufficient for practice. A table giving calculations for the arch angle and a diagram with all necessary quantities and estimates accompanies the article. M.V.K.

Sven Pulson, pioneer abrasive maker, dies. ANON. *Abrasive Ind.*, **11** [2], 62 (1930).—Sven Pulson, pioneer of emery wheel manufacturers and for 20 years superintendent of the Abrasive Material Co., now known as the Abrasive Co., died in Philadelphia recently, following an attack of heart disease. He was 82 years old. E.P.R.

N. B. M. A. meeting. ANON. *Brick Clay Rec.*, **76** [3], 175–77 (1930).—A report of the meeting held at Memphis, Tenn., February 4 to 6, is presented. The pledge for the advance of technical knowledge was renewed. Five of the twelve committees presented papers showing the progress of their work this past year. A brief summary of some of the papers read is presented. Henry C. Kleymeyer was selected as president to succeed J. Otis Wilcox. E.J.V.

Sand-lime brick producers meeting. ANON. *Brick Clay Rec.*, **76** [3], 194 (1930).—Papers read at the meeting of the Sand-Lime Brick Association meeting in New York, February 4 to 6, 1930, are listed. E.J.V.

Establish research company. ANON. *Abrasive Ind.*, **11** [2], 63 (1930).—Theodore Swann, president of the Swann Corp., announces the formation of Swann Research, Inc., with a capital of $250,000, and laboratories at Anniston, Ala., to coördinate and unify the research and development activities of the various subsidiaries of the Swann Corp. E.P.R.

Cambridge Tile Manufacturing Co. ANON. *Ceram. Ind.*, **14** [2], 190–98 (1930). F.P.H.

U. S. exports of nonferrous metals and minerals. DONALD P. LLOYD. *Commerce Repts.*, **7**, 445–47 (1930).—Exports of nonferrous metals and minerals, exclusive of gold and silver bullion, coins, and ore, during 1929 exceed in value the exports of 1928 by $63,174,301, or 6.8%, which is more than the average year-to-year expansion rate since 1920. Glass and glass products, clay and clay products, gypsum, magnesia and manufactures, mica and manufactures, and abrasives showed moderate increases in value of exports. E.J.V.

Pottery enterprise in South Australia. ANON. *Australasian Mfr.*, **14** [717], 33 (1929).—An account of the activities of the Adelaide Potteries, Ltd. H.H.S.

Expansion of Danish glass works. ANON. *Amer. Glass Rev.*, **49** [18], 16 (1930).—"Holmegaards Glasvaerk," Denmark, a relatively large producer of fine tableware, and a subsidiary of the well-known Danish Royal Copenhagen Porcelain Factory, recently announced plans to increase its present plant capacity by 500,000 kilos per year. A new kiln will be constructed which will increase the plant capacity from 800,000 kilos to 1,300,000 kilos and the number of employees to 300. E.P.R.

Italian pottery and glass industry. ANON. *Pottery Gaz.*, **55** [632], 274 (1930).—The present position of the Italian pottery industry is characterized by a certain lack of agreement between the various branches of the industry. While electrical porcelain and sanitary earthenware makers are well supplied with orders, the slow business in the finer ceramics is more marked. This is chiefly ascribed by the Italians to the keen competition of the Czechoslovakian and German makes on the Italian market. Fire-

proof-ware makers complain of very poor business. In the glass industry the end of the year failed to produce the hoped-for improvement in business. E.J.V.

Products manufacture checks up. F. W. SCHNOEBELEN. *Concrete*, **35** [6], 23–24 (1929).—S. presents some simple methods for checking up on the year's activities. E.A.H.

What an association can do. ALFRED REEVES. *Concrete*, **35** [6], 111–13 (1929). E.A.H.

PATENT

Ceramic products. A. CARPMAEL. Brit. 321,739, Jan. 8, 1930. Colored brick, earthenware, and other ceramic products are obtained by incorporating ferrous-ferric oxide, as chemically produced in a finely divided state, with a clay or clay mixture and then forming and firing. Suitable oxides are obtained in the reduction of aromatic nitro compounds to the corresponding amines by the processes described in Brit. 274,562 and 279,283, or by precipitating ferrous hydroxide from a ferrous salt and oxidizing by heating. Other coloring agents, for instance manganese black and ocher, may also be added.

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Vol. 9 **April, 1930** **No. 4**

EDITORIAL

PRESIDENT'S ADDRESS[1]

GEORGE A. BOLE

If by a President's address you think of a preachment on a given subject my talk does not qualify. I wish rather to review for you in the short time allotted to me the activities of the SOCIETY and our needs as I see them.

The AMERICAN CERAMIC SOCIETY has grown so rapidly in the past few years and has come to include such a diversity of interests that we can scarcely classify ourselves more definitely than by saying that we are an association of people interested in the success of the ceramic industries.

Some of us are chemists, others engineers, others artists, and still others are particularly interested in the field of management. Then there are those versatile chaps who solve production problems and indulge in sales activities with equal abandon and success. Some of us are in the laboratory, some in the plant, and others in the field.

Service has become a major aspect of sales and the so-called trouble shooter is a permanent appendage to the sales department. Sales engineering when not a platitude describes a very specific service to the in-

[1] Presented at the Annual Meeting, AMERICAN CERAMIC SOCIETY, Toronto, Ont., February, 1930.

dustry. The more technical aspects of sales are coming to demand the highest type of technical training.

With such an array of diversified interests represented in our organization it is small wonder that we look at things differently.

It is at the same time a challenge to our membership and a responsibility on the part of our officers to blend so many interests into a coherent and purposeful organization.

The situation has presented itself in its two extremes this year and your officers have endeavored to meet it according to their light.

Those most interested in the sciences and the scientific aspects of engineering have proposed a science division where papers of general scientific interest would be presented.

The proposal to create a special membership within the SOCIETY to be known as the fellow grade is a move to fill the same needs.

On the other hand a special session in the Heavy Clay Products Division will be devoted to masonry construction problems. The Board last year decided to feel out the sentiment of the SOCIETY in regard to a Management Section. The two management luncheons this year are a cautious approach to the problem.

Whether expositions constitute a proper activity for a technical society has been seriously questioned by some of our members. (Also the question has been raised as to whether we are slipping as a technical society in sponsoring an activity so closely allied to sales.) I, personally, would be opposed to expositions if I thought a let down in science and technology a corollary to an interest in such things.

With forebodings on the part of some and with considerable enthusiasm on the part of others we have decided to sponsor an exposition in Cleveland next year.

I point these things out as evidences that we have within our organization, not only a diversity of ideas and ideals, but an impetus to expand; a desire to serve a larger and more diversified field.

While some of us may be interested primarily in sales, some in production, others in research or in art, we are all at the last analysis interested in a product. Whether we are as a SOCIETY to wash our hands of the product when it has been fabricated is the problem which we are now facing.

The condition of the ceramic industries during the past year has been unsatisfactory on the whole, and critical in some branches. What is our SOCIETY doing to improve the situation?

Through our printed matter we have contributed in a large way to the problems of production. We have a fair grasp of these problems and, I believe, are meeting them about as successfully as most industries. We have, however, shown little tendency to produce new products or to find new uses for present ones. We have not utilized the skill of the

artist or the genius of the research man to improve our ware. We have been imitators rather than originators. We have obeyed rather than created a demand for distinctive products. Only a few isolated instances can be pointed out where we have sensed a demand before it became articulate. While a few isolated instances can be brought to mind where research and art have been utilized to advantage such use has never been adopted by our industry as a policy as in the automobile, paint, rubber, and cement industries.

The Art Division under the able leadership of Mr. Curtis is essaying a closer contact with industry in a large way. They are questioning how art can serve industry most effectively.

Much as we need the services of the artist, the scientist, and the technologist to place the ceramic industries on a higher level, I believe, just now we need to initiate a fact-finding campaign in other fields.

I would like to emphasize the need for engineering data for ceramic products in the structural materials field. Industries producing competing materials have gone far ahead of us. We have used sentiment rather than facts in making recommendations in regard to the use of our materials. Not having the facts, and having the material for sale, it is small wonder that this has been the case.

We are in a way unfortunate in that we have excellent products which were for generations taken for granted, but in this engineering age where nothing is taken for granted we find ourselves without the unbiased quantitative data so sought after by architectural and construction engineers. Due to these causes ceramic materials are losing out in many of our general building codes and civic zoning regulations.

In order that the architect, construction engineer, and clay products producers may reach a better understanding of each other's problems we are sponsoring a structural materials conference in the Heavy Clay Products Division. Our Secretary has been active in this field during the past year.

As a part of this program the structural materials men are looking into the possibility of arriving at a standard unit size for each structural unit material. There are many aspects to the proposition. We are to discuss the engineering and technical aspects. We hope that our discussions may clarify the situation somewhat and stimulate the trade associations to look into the trade and merchandising aspects of the problem.

Such work again emphasizes the need for a Ceramic Research Council such as has been advocated by the SOCIETY for some time. In this particular case it would serve as a neutral fact-finding body which would sponsor research and the securing of test data. It could speak with authority for all structural clay products.

An engineer's hand book of structural clay products containing all the

known data required by architects and builders would do more than any one thing to stimulate a lagging confidence in fired clay structural materials. Such a hand book should be put out by a technical society and not by a trade association.

Our SOCIETY has recently brought out an excellent bibliography on enamels which was preceded by similar works in other fields. More such material is needed. A bibliography of whiteware literature is probably the most urgent need just now.

The SOCIETY would do well to sponsor, if not publish, monographs on special subjects in our general field. We have recently felt the need for a monograph on glazes and glazing. The American Chemical Society and the American Society of Mechanical Engineers have rendered a fine service in their respective fields by encouraging the publication of monographs.

Our abstracts constitute a work of which we can be proud. The need created by an ever increasing literature makes the task increasingly arduous. An *Abstract* editor is a present need.

All of these activities together with many others in which we should be interesting ourselves require money. Your Budget Committee has been facing the serious problem of placing the ever expanding activities of the SOCIETY on a sound financial basis. They recommend an increase in dues as one of several possibilities.

In the midst of all these activities we have not been unmindful of the quality of the papers presented at our Annual Meetings. Every effort is being made by the divisional committees to make the section programs more purposeful and in order to give an added impetus to the movement, a committee on awards is working out a plan which aims to create a medal in each Division to be awarded to the best paper presented during the year. The committee has undertaken a fine piece of work and is about ready to announce the conditions of competition and the method of award.

We are fast becoming international in the scope of our membership. We now have over three hundred foreign members. By the same token we are becoming more neighborly. We have made our maiden tour, as a SOCIETY, of England and the continent and will be represented officially at the Wedgwood Bicentenary to be celebrated at Stoke in May.

We acted as host to the British Society last year and are in the midst of preparations to receive a delegation from the French Ceramic and Glass Societies early this spring.

I have thus briefly outlined our SOCIETY'S activities during the year and have given you some idea of the problems involved together with suggestions as to what we should be doing as a society, as I see our needs.

PAPERS AND DISCUSSIONS

HANDLING CLAY PRODUCTS WITH STORAGE BATTERY TRUCKS[1]

By H. R. Straight

ABSTRACT

Economies of storage battery trucks which have been proved are cited. Comparison of cost of wheelbarrow and truck methods is given showing that trucks will pay for themselves the first year, have low cost upkeep, and will last for twelve or more years.

Introduction

The stocking, shading, and grading methods of brick plants in vogue ten years ago are nearly as out-of-date as the conclusion of the Ohio schoolboard that "railroads and telegraphs are impossible and heresy." The wheelbarrow and some of the other equipment is nearly as obsolete as the horse and buggy.

Among the important basic problems are the reduction of costs, increase of profits, and the handling of larger quantities of material. In the manufacture of heavy clay products about 80% of the labor costs are for manual handling. A storage battery truck handling a load five to ten times greater than a manually pushed wheelbarrow at a speed two to three times greater than a man can travel offers obvious advantages. The efficiency of the truckman may in some cases be twenty times that of the wheelbarrow man.

Efficiency of Truck

A three-ton portable rack will easily carry 1200 four and one-half pound brick units at ten to twelve miles per hour even for the short distances generally traveled. A man who will push a wheelbarrow load of one hundred brick at the rate of four miles per hour and keep it up is either blessed with an excess of energy or is working on a piece-work or bonus basis.

Figures show that men pushing wheelbarrows could earn not more than six to eight cents per hour in competition on an equal cost basis with a truck using current costing one and one-half cents per kilowatt.

Operating Costs for Truck and Accessory Equipment

The total cost for truck operation is forty to sixty cents per hour, depending upon the kind of work the truck is doing and the conditions under which it is operating. In addition, the interest costs for racks, platforms, and runways, and upkeep costs will reach approximately fifteen cents

[1] Presented at the Annual Meeting, American Ceramic Society, Toronto, Ont., February, 1930 (Heavy Clay Products Division). Received January 20, 1930.

per hour per truck. It is conservative to say that a truck operating eight to ten hours per day, doing the work of twelve wheelbarrows will make a clear profit over the wheelbarrow system of $5000 per year, and retire the entire cost of all the equipment the first year. We know no way of effecting a more clean cut increase in profits than by the use of one of these trucks.

Life Expectancy of Trucks

Our experience shows that tires last for approximately thirty thousand tons handled over an average of two hundred feet, or that the tires last about one year.

Edison batteries operating on a ten-hour day will last four years. We have had no experience with lead batteries.

Minor items of upkeep such as controller parts, etc., cost twenty-five

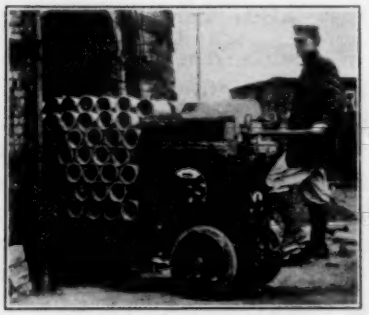

FIG. 1.

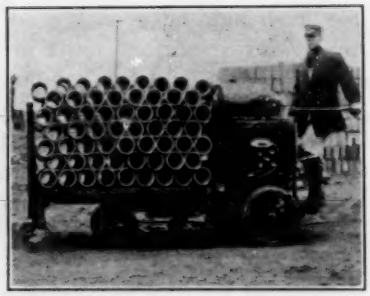

FIG. 2.

to forty dollars per year. General repairs otherwise on the trucks now manufactured are practically nothing and the trucks themselves should last at least twenty years.

Figure 1 shows the first truck put into operation by the Adel Clay Products Company in 1914. This truck is working and giving excellent service after traveling 50,000 miles and handling approximately 375,000 tons of ware. This truck has the same motors and most of the same gearing as originally installed.

Truck companies state that 90% of the trucks made in the last twenty years are still in active service.

Weather Does Not Affect Output

Demand for clay products usually is at its peak during the hot summer months when it is difficult, and in fact many times impossible in the

average plant, to keep the output of the plant up to capacity without adding extra men or working overtime. The storage battery truck runs equally well at zero or 100° in the shade. It will work through mud or slush if it is solid underneath. Even though the yard may not be shedded a truck operator with a raincoat can keep the output rolling out and into cars without delay during rainy days.

One Truck Could Work Two Shifts

By providing two complete sets of batteries it is perfectly practical to expect a truck to operate two shifts and thereby spread the investment costs over a larger output.

Loading and Unloading Kilns

Due to the weight of the truck and the portable racks it is advisable that steel sheets be used to protect the kiln floor during the unloading of the kiln to avoid excessive break-

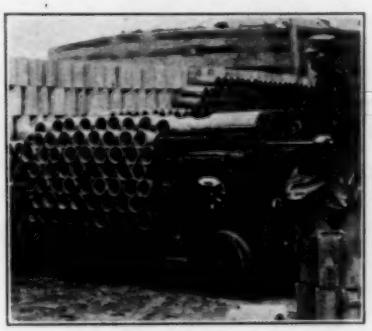

FIG. 3.

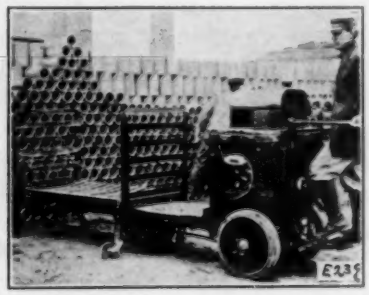

FIG. 4.

age of floor tile. These sheets should be three feet square and provide two paths from the entrance door.

The portable racks for holding the loads should be made with castors on all four corners so that the load may be turned in the car to allow greater convenience in unloading and allow three men to work at the unloading of each rack if necessary to keep the truck busy. The castors should be of especially easy swiveling design and the wheels of the castors must be large enough to roll over a rough car floor without excessive effort on the part of the unloaders.

Kiln unloading, it is found, is materially speeded up if a portable belt conveyer is used to run the material from the upper five feet of the setting out of the kiln to men outside piling it on the racks. The truck goes into

the kiln for the remainder. By conveying the top part of the kiln out into the open, shading and grading is done more accurately.

Stock Racks

By providing a considerable number of extra racks it is possible to stock the rapidly selling units on racks ready to unload at a minute's notice, thereby saving two handlings and some damage to the ware. If racks of simple and inexpensive steel construction without castors can be used twenty-five cycles per year, they will pay for themselves annually in the saving of labor alone.

Attitude of Labor

Experience has shown that having carefully planned the arrangements of runways and platforms, a truck always lightens the work as compared with manual methods and that labor is then in a receptive mood for additional equipment where it can be used. It will be found that new help can be much more easily trained and retained on the job where trucks are used.

Design of Truck

It was considered necessary to have a truck made of special design when we purchased our first truck. This design called for 15-inch load-carrying, or trailing wheels, and 21-inch drive wheels and was built accordingly. Standard warehouse trucks usually have $10^1/_2$-inch wheels for the trailing wheels which will not operate successfully on a cinder yard, but we find that 15-inch wheels will go almost anywhere if the yard is well cindered, drained, packed, and not slippery.

Summary

It is said that "90% of manufacturing is the moving of materials." The average brick plant uses at least 30% of its labor in handling fired products out of the kiln into stock or cars and out of stock into cars. One-fourth of the time of wheelers is spent wheeling. The capacity of all men handling ware is increased by the use of trucks by approximately 20% because of the larger unit loads and fewer delays in changing. Taking all these phases into account in our plant this amounts to a saving of approximately $17.00 per truck day, or $50.00 per day when our three trucks are required to handle the material being moved.

Wheelbarrows, push trucks, gravity conveyers, and storage battery elevating platform trucks have been tried, but the elevating platform storage battery truck is recommended as the best solution for the handling of heavy clay products.

Adel Clay Products Company
Adel, Iowa

BONUS METHODS OF WAGE PAYMENT AS RELATED TO PRODUCTION[1]

By H. R. Straight

ABSTRACT

The factors entering into the set-up of a bonus system designed to increase production together with lower costs, decrease in labor turnover, and maintaining the quality up to standard are discussed.

Introduction

A large percentage of the unskilled labor working on a straight hourly basis have very little incentive for doing any more work than just enough to hold their jobs. This is not at all true when the same men are taken into partnership and a bonus system is installed. As a result wholly different men are made of them.

A bonus system that increases wages and production, lowers costs, and keeps the quality of the ware up to a high standard is an intricate problem of management engineering. The problem must deal among other things in engineering, manual handling, drying, firing, statistics, and human nature. An efficiency expert not familiar with this business may be as far off as in the case where a farmer's boy could pick six quarts of berries an hour and the neighbor's girl could pick five, but the statistics did not hold true when, for some reason, the two together could only pick four.

When once established, a good bonus system runs smoothly, aids production, and is, apparently, very simple. Of course changing conditions will at times call for a slight change in the system or rules. A good system has the same effect as pouring oil on rough water; everyone benefits and is anxious to see the output move along.

Experience is necessary in working out the best bonus system for each individual plant. One poor rule may have a psychological effect that will lower the morale of the plant employees to the extent that the bonus system will fail to accomplish its purpose. There are little things that will come up that the manager skilled in the working of a bonus system should foresee and should be able to forestall before much damage has been done.

The basis that must appeal to the workmen is the question of how they can increase their earnings if they put forth unusual effort and interest. Immediately, from the management side, comes up the question, how far can the management go with this and profit by it? Some of the basic principles entering into the design of a good system are as follows:

Basic Principles

(1) The time period over which the bonus extends must be short.

(2) The system must develop a maximum of team work between the various groups and the plant management.

[1] Presented at the Annual Meeting, American Ceramic Society, Toronto, Ont., February, 1930 (Management Session). Received January 13, 1930.

(3) The system must be so established that the poorest workman will realize that his efficiency is automatically reflected in his pay check.

(4) The system must be so simple that every man can tell whether or not his bonus has been accurately calculated.

(5) The system must be operated by employees who are directly benefited to the same extent as the others.

(6) The system must provide a means of allowing both the employees and the management to benefit by a labor saving improvement.

(7) The system must provide a step in rates above production previously obtainable, to encourage unusual effort and head work by those benefited, and steady production toward that end.

(8) Quality products must be turned out in quantity.

Time Period For many years we used a period of one month. The disadvantage found was that there was a tendency in short months to feel that they were laboring under the handicap of less time to accomplish the set production. Also if weather conditions interfere in the forepart of a month, best efforts were discouraged for the remainder of the month.

A period of one day is too short for the reason that there are ware units that naturally are slow handling and unprofitable to the plant, which must be manufactured. A poor day's run would effect only one day's bonus if a day-period is used, while the employees should stand their share of this loss as they generally would in a weekly bonus period. A day bonus system is burdensome to the clerical department.

Our experience shows that a period of a week works out best. On weeks having a holiday the bonus can be paid on a basis in the proportion that time worked bears to the full week which gives the same basis of incentive.

Team Work If group or departmental coöperation is not developed by the basic rules or if separate bonuses apply to the different groups separately, friction and jealousy are sure to appear and interfere with the full intent of any system. It is necessary that each group hold up its end and coöperate with the management to secure good bonuses.

Millroom tonnage runs have proved to be the best bases for all groups, for it is obvious that unless kilns are emptied on time the filling and molding is delayed. Cars to be loaded or finished loading from the yard stock must be included in the task set by the system for this is part of the regular work that must be expected and an attempt to separate this work will greatly complicate the system. The employee must understand and be made to feel that excess stock must be moved when the orders are available so that the plant may run steadily through dull periods.

Increase Pay Check The bonus system we have developed after many years experience now takes account of a period of even five minutes time wasted if that five minutes is paid for through the timebook. The method of making this clear to the workmen has resulted in

Week Millroom Run Tonnage (sale wts.)

Man hrs. per ton	700 710	710 720	720 730	730 740	740 750	750 760	760 770	770 780	780 790	790 800	800 810	810 820	820 830	830 840	840 850	850 860	860 870	870 880	880 890	890 900	900 910	910 920	920 930
4.5																						$0.28	$0.48
4.4																			$0.13	$0.41	$0.60	0.88	1.09
4.3																$0.04	$0.24	$0.52	0.72	1.00	1.20	1.48	1.70
4.2														$0.12	$0.33	0.61	0.82	1.10	1.31	1.59	1.80	2.08	2.31
4.1												$0.18	$0.40	0.68	0.90	1.18	1.40	1.68	1.90	2.18	2.40	2.68	2.92
4.0										$0.12	$0.45	0.73	0.96	1.24	1.47	1.75	1.98	2.26	2.49	2.77	3.00	3.28	3.53
3.9								$0.24	$0.48	0.66	1.00	1.28	1.52	1.80	2.04	2.32	2.56	2.84	3.08	3.36	3.60	3.88	4.14
3.8						$0.24	$0.49	0.77	1.02	1.20	1.55	1.83	2.08	2.36	2.61	2.89	3.14	3.42	3.67	3.95	4.20	4.48	4.75
3.7				$0.22	$0.48	0.76	1.02	1.30	1.56	1.74	2.10	2.38	2.64	2.92	3.18	3.46	3.72	4.00	4.26	4.54	4.80	5.08	5.36
3.6		$0.18	$0.45	0.73	1.00	1.28	1.55	1.83	2.10	2.28	2.65	2.93	3.20	3.48	3.75	4.03	4.30	4.58	4.85	5.13	5.40	5.68	5.97
3.5	$0.40	0.68	0.96	1.24	1.52	1.80	2.08	2.36	2.64	2.92	3.20	3.48	3.76	4.04	4.32	4.60	4.88	5.16	5.44	5.72	6.00	6.28	6.58
3.4	0.90	1.18	1.47	1.75	2.04	2.32	2.61	2.89	3.18	3.46	3.75	4.03	4.32	4.60	4.89	5.17	5.46	5.74	6.03	6.31	6.60	6.88	7.19
3.3	1.40	1.68	1.98	2.26	2.56	2.84	3.14	3.42	3.72	4.00	4.30	4.58	4.88	5.16	5.46	5.74	6.04	6.32	6.62	6.90	7.20	7.48	7.80
3.2	1.90	2.18	2.49	2.77	3.08	3.36	3.67	3.95	4.26	4.54	4.85	5.13	5.44	5.76	6.03	6.31	6.62	6.90	7.21	7.49	7.80	8.08	8.41
3.1	2.40	2.68	3.00	3.28	3.60	3.88	4.20	4.48	4.80	5.08	5.40	5.68	6.00	6.28	6.60	6.88	7.20	7.48	7.80	8.08	8.40	8.68	9.02
3.0	2.90	3.18	3.51	3.79	4.12	4.40	4.73	5.01	5.34	5.62	5.95	6.23	6.56	6.84	7.17	7.45	7.78	8.00	8.39	8.67	9.00	9.28	9.63
2.9	3.40	3.68	4.02	4.30	4.64	4.92	5.26	5.54	5.88	6.16	6.50	6.78	7.12	7.40	7.74	8.02	8.36	8.64	8.98	9.26	9.60	9.88	10.24
2.8	3.90	4.18	4.53	4.81	5.16	5.44	5.79	6.07	6.42	6.70	7.05	7.33	7.68	7.96	8.31	8.59	8.94	9.22	9.57	9.85	10.20	10.48	10.85
2.7	4.40	4.68	5.04	5.32	5.68	5.96	6.32	6.60	6.96	7.24	7.60	7.88	8.24	8.52	8.88	9.16	9.52	9.80	10.16	10.44	10.80	11.08	11.46
2.6	4.90	5.18	5.55	5.83	6.20	6.48	6.85	7.13	7.50	7.78	8.15	8.43	8.80	9.08	9.45	9.73	10.10	10.38	10.75	11.03	11.40	11.68	12.07
2.5	5.40	5.68	6.06	6.34	6.72	7.00	7.38	7.66	8.04	8.32	8.70	8.98	9.36	9.64	10.02	10.30	10.68	10.96	11.34	11.62	12.00	12.28	12.68

Table I

Weekly Bonus Payments

Run Tonnage (sale wts.)

0	890 900	900 910	910 920	920 930	930 940	940 950	950 960	960 970	970 980	980 990	990 1000	1000 1010	1010 1020	1020 1030	1030 1040	1040 1050	1050 1060	1060 1070	1070 1080
			$0.28	$0.48	$0.78	$0.98	$1.28	$1.50	$1.82	$2.04	$2.36	$2.60	$2.94	$3.18	$3.52	$3.82	$4.22	$4.52	$4.92
13	$0.41	$0.60	0.88	1.09	1.39	1.60	1.90	2.13	2.45	2.68	3.00	3.25	3.69	3.84	4.18	4.49	4.89	5.20	5.60
72	1.00	1.20	1.48	1.70	2.00	2.22	2.52	2.76	3.08	3.32	3.64	3.90	4.24	4.50	4.84	5.16	5.56	5.88	6.28
31	1.59	1.80	2.08	2.31	2.61	2.84	3.14	3.39	3.71	3.96	4.28	4.55	4.89	5.16	5.50	5.83	6.23	6.56	6.96
90	2.18	2.40	2.68	2.92	3.22	3.46	3.76	4.02	4.34	4.60	4.92	5.20	5.54	5.82	6.16	6.50	6.90	7.24	7.64
49	2.77	3.00	3.28	3.53	3.83	4.08	4.38	4.65	4.97	5.24	5.56	5.85	6.19	6.48	6.82	7.17	7.57	7.92	8.32
08	3.36	3.60	3.88	4.14	4.44	4.70	5.00	5.28	5.60	5.88	6.20	6.50	6.84	7.14	7.48	7.84	8.24	8.60	9.00
67	3.95	4.20	4.48	4.75	5.05	5.32	5.62	5.91	6.23	6.52	6.84	7.15	7.49	7.80	8.14	8.51	8.91	9.28	9.68
26	4.54	4.80	5.08	5.36	5.66	5.94	6.24	6.54	6.86	7.16	7.48	7.80	8.14	8.46	8.80	9.18	9.58	9.96	10.36
85	5.13	5.40	5.68	5.97	6.27	6.56	6.86	7.17	7.49	7.80	8.12	8.45	8.79	9.12	9.46	9.85	10.25	10.64	11.04
44	5.72	6.00	6.28	6.58	6.88	7.18	7.48	7.80	8.12	8.44	8.76	9.10	9.44	9.78	10.12	10.52	10.92	11.32	11.72
03	6.31	6.60	6.88	7.19	7.49	7.80	8.10	8.43	8.75	9.08	9.40	9.75	10.09	10.44	10.78	11.19	11.59	12.00	12.40
62	6.90	7.20	7.48	7.80	8.10	8.42	8.72	9.06	9.38	9.72	10.04	10.40	10.74	11.10	11.44	11.86	12.26	12.68	13.08
21	7.49	7.80	8.08	8.41	8.71	9.04	9.34	9.69	10.01	10.36	10.68	11.05	11.39	11.76	12.10	12.53	12.93	13.36	13.76
80	8.08	8.40	8.68	9.02	9.32	9.66	9.96	10.32	10.64	11.00	11.32	11.70	12.04	12.42	12.76	13.20	13.60	14.04	14.44
39	8.67	9.00	9.28	9.63	9.93	10.28	10.58	10.95	11.27	11.64	11.96	12.35	12.69	13.08	13.42	13.87	14.27	14.72	15.12
98	9.26	9.60	9.88	10.24	10.54	10.90	11.20	11.58	11.90	12.28	12.60	13.00	13.34	13.74	14.08	14.54	14.94	15.40	15.80
57	9.85	10.20	10.48	10.85	11.15	11.52	11.82	12.21	12.53	12.92	13.24	13.65	13.99	14.40	14.74	15.21	15.61	16.08	16.48
16	10.44	10.80	11.08	11.46	11.76	12.14	12.44	12.84	13.16	13.56	13.88	14.30	14.64	15.06	15.40	15.88	16.28	16.76	17.16
75	11.03	11.40	11.68	12.07	12.37	12.76	13.06	13.47	13.70	14.20	14.52	14.95	15.29	15.72	16.06	16.55	16.95	17.44	17.84
34	11.62	12.00	12.28	12.68	12.98	13.38	13.68	14.10	14.42	14.84	15.16	15.60	15.94	16.38	16.72	17.22	17.62	18.12	18.52

Table I

ly Bonus Payments

the building up of a chart shown in Table I. This table makes use of the total hours worked weekly, divided by the tonnage actually run in the mill-room to obtain the basic horizontal column headings or man hours per ton. The total basic tonnage to be made based on standard fired sales weights are used in the vertical column headings.

It is decided how many cents per ton can safely be allowed as a bonus after taking account of all other costs from a plot of costs as shown in Fig. 1. The amount set aside for total bonus divided by the number of men on the payroll gives the basic individual bonus per ton.

Figure 1 also clearly shows that the correct total labor costs added to the other costs will permit a total manufacturing cost low enough to give a

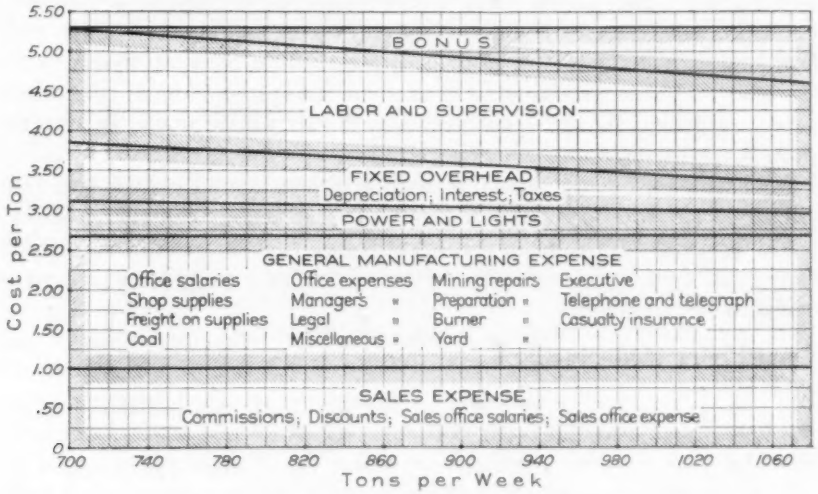

FIG. 1.—Total manufacturing and sales costs.

correct profit in the various tonnage columns. The upper line is fixed as a horizontal line to fix a uniform cost per ton average over the plant output. Any increase in the payroll for day wages comes off the bonus, and vice versa, making a variable line between bonus and labor costs depending on labor efficiency. Accordingly, if a high bonus is paid, a correspondingly less cost may be expected to be paid out on day wages. This is illustrated by the principle of creating incentive without increasing costs.

To arrive at the complete quantities of bonuses under the various tonnage column headings at the varying efficiencies of work done, the following formulas are used:

$$\text{Basic bonus} \pm \frac{H \times R}{N} = \text{bonus paid}$$

Basic bonus = bonus amount set per man to allow a fair profit per ton
H = hours saved or lost
R = average hourly wage
N = number of men on payroll

For example, to illustrate the use of this formula, from the 900-ton column it is evident that a saving of one-tenth man hour per 900 tons week output, means 90-man hours saved, which, at the average hourly rate of 38 cents and 57 men on the payroll, means a saving on payroll of 60 cents per man per week. This is added to the basic bonus when the payroll shows that the efficiency of the workmen has increased above the basic man hours per ton.

A large percentage of workmen have been found to have a well developed sense of fair play in trying to hold up their end of the task consigned to them and that while their efforts often miscarry they are well intended. Where a bonus system is so clearly established as to leave no room for doubt as to how each is benefited, it is to their interest, collectively, to maintain the efficiency. Those who have never used such a system have in store many happy surprises relative to the suggestions that will be made by even the slowest workmen to improve efficiency.

Men that are not interested or capable of producing for their own individual benefit will be largely eliminated by the caustic comments of their fellow workers. If the bonus is correctly based their place will be automatically filled by men attracted to the job by the higher pay as compared to competitive industries.

Rules Understandable by Workmen

Printed schedules and rules are advisable and each time a new rule is made or a change in the schedule is necessary, a called meeting of all employees is advisable in order that anyone may express an objection or an idea that may improve conditions or better the general feeling. It is advisable in adding new men to explain in detail the way the schedule is derived and the various simple rules, in order that each may be brought to feel his importance as a link in the complete chain.

Operated by Employees

The system must be operated by employees to remove any thought of distrust as to the correct calculating of a bonus based on the tons manufactured. The basic figures necessary are taken from cost records. The figures necessary from week to week add comparatively nothing to the clerical expense.

Employee and Employer Both Benefit

The operation of labor-saving devices is generally subject to an analysis as to the savings of labor that may be expected. Such devices generally require power and repairs, and are subject to depreciation and obsolescence. These and other factors of expense must be taken into consideration. A bonus system that does not permit a change in schedules upon the installation of such devices will penalize the profits of the plant.

For example, coal-handling equipment is soon to be installed in this plant. We have been shoveling coal into dump wagons. It is estimated that two-thirds of the coal-handling time will be saved. At 900 tons there were used 90 hours per week shoveling and hauling. Therefore, with 60 hours saved at 38 cents per hour average the 57 men would be benefited to the extent

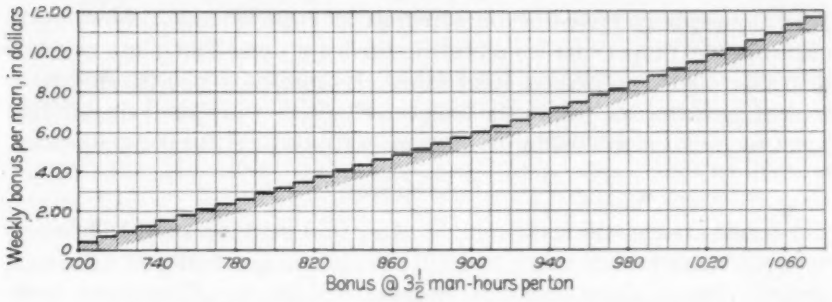

FIG. 2.—Illustrating step in rate above normal production.

of 40 cents per man per week, which, instead of accruing to the benefit of the men, should be saved by the management. A change in the printed schedule is therefore advisable if the improvement is to pay its way.

Rates Must Produce Increase Wages

It will be noted in Fig. 2 that above 1000 tons per week the general slope of the plot is upward at a sharper angle, indicating the degree of the step-up of the rate as production is obtained above the capacity that has been

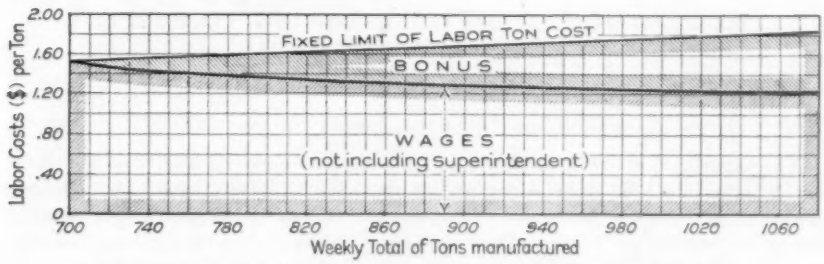

FIG. 3.—Illustration flex. div. line between bonus and wages. Shown at $3^1/_2$ man-hours experienced efficiency.

reasonably expected. It will be admitted that 1000 tons weekly fired weight of hollow ware through one machine is an unusual production that means a very good profit. In order to make a greater incentive the bonus is, therefore, very high. In fact, it is thought that with some adjustments and some added kiln capacity, our bonus payments will perhaps be nearly as high as the hour wage payments.

Quality in Quantity

In establishing a base it seems best to take results allowing for a certain previously experienced loss in drier and firing processes, and from such figures deduct the loss from millroom weeks run due to careless handling only. It is generally not the direct negligence or carelessness of the employee when an unusual loss is experienced in the drier or kilns, and the loss due to careless handling is generally easily corrected by the superintendent or foreman. Most workmen will take proper care from pride in their work and they must be made to realize that competition from other clay products plants, and other competing materials, will in the long run eliminate their job if the product is not such that it will sell in the open market at a profit to their company.

Conclusion

A bonus system will make a plant easier and more pleasant to manage, more profitable to the owners, and will place it on a better all around footing than if operated either on a day- or piece-work basis. Experience shows that piece work, on account of some being paid so much more than others, causes friction. There is a tendency to carelessness in piece work without the team play between groups that produces unusual output and profit.

Our experience with the operation of plants during the last seventeen years paying on a bonus basis of some kind has been that our labor has been more contented than the labor in competing plants working under other plans of wage payment, and we feel we have had a better class of men.

ADEL CLAY PRODUCTS COMPANY
ADEL, IOWA

THE RELATION OF METAL CLEANING TO PERFECT ENAMELING[1]

BY EDW. L. MCILHENNY

ABSTRACT

The importance of the cleaning phase of the enameling process as related to production of uniformly good work is not always appreciated. Many troubles encountered commonly in porcelain enameling plants can be traced to the pickling department turning out unclean work. In order to control the cleaning properly there are a number of points which should be considered, such as type of lubricant used, production schedule, evidence of water hardness, and selection of proper type of cleaner.

A method has been suggested which applies to the water-break test for determining the exhaustion point of the cleaning tank. Rinsing, packing or racking, and electrolytic cleaning are also of importance and merit consideration.

Introduction

Any paper concerning metal cleaning and its fundamentals must neces-

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sarily be rather inclusive, and, therefore, may apply to other lines of the metal industry than enameling alone. It is the intention in this paper, however, to hold as closely as possible to the problems of metal cleaning as related to the enameling industry.

"Cleaning" is one of the most important though often misunderstood and neglected phases of the manufacture and finishing of a great variety of metal articles. It is regarded by many as being a necessary evil, and receives a corresponding amount of attention. The plating industry depends entirely on cleaning of the base metal in preparation of the work for the plating tanks. Other industries are similarly situated, but the problem before us is that of the enameling industry.

With the increase in the use of enameled products and the improvements made on the already widely used articles covered with the familiar coating, it is becoming more and more necessary that the utensil, stove, sign, etc., be perfect in every detail. The selection of dependable materials, the proportioning of the frit composition, the proper milling, dipping, and firing are all of prime importance. It is equally important, however, that the stock be properly cleaned and pickled.

It has been stated by one who has spent many years in the enameling industry that troubles encountered commonly in porcelain enameling plants can, more often than not, be traced to the pickling department turning out unclean work. Ware properly cleaned will not have to be returned to the pickle room because of faulty preparation. No matter how good the enamel, how perfect the temperature of the furnace, if the base is not clean there will be a lack of uniformity in the work and the results will not be dependable.

Defects Due to Unclean Ware

A few of the enamel troubles which can sometimes be attributed to unclean ware are (1) fishscale, (2) jumpers or jumping, (3) copperheads, and (4) pinholes or blistering.

There are a few more troubles which originate from sources outside the pickle department, such as crazing, shiners, black specks, hair lines, chipping, etc., but the troubles with which we are concerned are those that are due to unclean sheet iron, and are preventable by proper cleaning.

Fishscaling Fishscaling due to underfiring, results in scale of the half-moon shape; caused from overfiring, it gives the shiner variety; or from overpickling, will probably be pronounced over the entire surface of the enameled piece. Scaling that is present only in spots on the ware can almost always be traced to improper cleaning. That is, the iron has not been thoroughly cleaned, pickled, and properly neutralized. Such a condition will prevent the enamel being applied thereon from obtaining a firm grip or bond on the metal surface.

Jumpers The defect in enamel called "jumpers" or "jumping" is due in most cases to a bare spot left in the ground enamel, exposing the iron underneath from which the enamel jumped while being fired. The jumping is the result of the enamel not having the proper grip on the iron, due in part to the inability of the enamel to wet the surface thoroughly. This, again, may be the result of dirt, rust, scale, or some other foreign matter.

Blistering and Pinholes During the firing operation of the ground-coat enamel at certain stages, gas is given off either from the iron or enamel. If the enamel has been applied too heavily it will be impossible for the gas to escape, and the coating will not become properly fused. While the enamel may not have blistered in this operation, it is possible that, since it has not completely fused, blisters will form in the next coat. If the metal has not been thoroughly cleaned from impurities, pinholes will develop. Often in the manufacture of porcelain enameled signs which have been fired many times due to the several colors necessary, the pinhole or blister will not show up until later firings.

Copperheads Copperheads, those dark red brown spots which occasionally appear in the sheet ground-coat enamel after firing, may be caused by thin enamel which does not have body enough to cover properly. Metal exposed to the heat becomes oxidized, or rusts, and the copperheads result. It is also possible that the ware, being improperly cleaned, will result in poor covering, and the result may be the same.

Cleaning under Control

It is not only necessary to see that the tanks are kept at the proper temperature and that the concentration of the cleaner is above the critical point but the type of oil and how long it has been on the ware is important. How much ware is going through the tank each day and when should additions be made? Are there water-hardness by-products to consider? Is the proper cleaner used? How long can the tank run before it is necessary to renew the solution? These questions are being asked every day by the men in the pickle rooms of enameling plants over the country, and should be seriously considered by those responsible for the operation of the pickle room.

Types of Oils From the standpoint of sheet-metal lubrication for drawing, stamping, etc., the chief physical properties demanded of a lubricant are (1) sufficient viscosity to prevent any considerable loss by dripping away from the metal and a retention of this viscosity at working temperatures and (2) a rapid and substantial film development.

The various types of oil commonly encountered in the enameling in-

dustry are mineral oils, fatty oils, sulphonated oils, and mixtures or compositions which are blends of certain oils, fats, and waxes, to produce a lubricant having composite properties. Some of the heavier compositions contain mineral lubricants such as talc, amorphous chalk, zinc oxide, lithopone, lead compounds, and similar compositions. Calcium soap as a base in various greases makes them difficult to wet and therefore hard to remove. These materials contribute a permanence factor to the lubricant, but often complicate matters by slow chemical reaction with the oil constituents and the metal itself.

It is extremely important that these compositions be so prepared as to retain a homogeneous condition. Separation of any of the constituents from the body of the composition is likely to upset the entire balance of properties. Good lubrication is primarily a matter of adhesion, and as adhesion usually increases with time up to a certain point, the firmness of the adhesion and age of the film have considerable bearing on the problems of removal.

Action of Cleaning Solution

In the efficient cleaning solution we find wetting, saponification, and emulsification to be the prime factors involved in the initial stages of cleaning. The efficient solution first "wets" the oil surface. If the oil is of the fatty glyceride type, or contains considerable such oil, a direct reaction between the oil and the alkaline medium in the solution will produce sufficient soap to increase the wetting power and speed up a loosening of the oil. The solution must be capable of emulsifying the separated oil by enveloping the oil droplets in a tough, resistant film which prevents their coalescence into larger drops, or re-attraction toward the metal surface.

After the upper layers of oil have been removed, the adhering adsorbed film must be disrupted and separated from the metal surface by counter-attraction. Effective cleaning solutions will possess colloidal properties which will exert a colloidal pull or force of greater magnitude than the adhesive force between the metal and the film, and in the opposite direction. The chemical action operates in conjunction with the physical colloidal action, with the result that the film constituents are separated and taken up into suspension by the cleaning solution. The cleaning solution displaces the film and wets the metal surface itself.

Making Cleaning Solution

Having once established the type of cleaner which will best handle the job in question, the next step in the procedure is to make up the tanks and have them ready to accommodate the flow of production as soon as possible. The usual procedure is to fill the tank to within about half of its operating capacity and heat the water to the boiling point. The cleaner is then added to the tank by scattering over the surface, so as to have each particle

of the material come into contact with the water as it falls down through the solution. The practice of shoveling the cleaner into the tank is wrong. After the cleaner has been added to the tank, the water level may be raised to the operating level and the tank again brought to the proper temperature. A boiling solution is the most efficient, of course, though good work may be done with a tank below the boiling point but agitated with air to produce the mechanical effect of the boiling solution.

Addition of Cleaner and Emptying of Tank

How much cleaner should be added from time to time, and when should it be added? When should the tank be emptied, keeping it long enough, of course, to get the most good out of the material put into it?

The amount of cleaner in the tank can be ascertained by titration by a standard acid solution. The number of cubic centimeters of solution needed to neutralize a standard amount of a given cleaner can be converted easily into the number of ounces of cleaner per gallon.

Cleaners of different compositions will require varying amounts of acid for neutralization. It is not always the alkaline content of the tank which governs its efficiency, and after a certain time that method would not prove effective. After a tank has run a certain length of time, it naturally accumulates a surplus of grease and other foreign matter from the ware as it passes through the solution and its saturation point is reached. After that time, no matter how much cleaner is added, the work is not done efficiently.

Water-Breaks

The orthodox method of telling whether a tank is functioning is to watch for water-breaks after the rinse. Since that is the most commonly accepted method, and will probably continue to be until a better method is found, it might be applied as a rough method for determining, before the day's work starts, whether the tank is in proper working condition.

The method is as follows:

Select a sheet of steel about one foot square and use the same one each day. Procure a small tank of a standard oil, preferably a mineral oil which is difficult to remove, and dip the sheet in this oil each morning. Hang it in the tank and time the cleaning. When a tank is made up fresh, the length of time it should take to clean the test sheet so that no water-breaks appear, can be established. Do that every day, and daily observations will eventually show that a longer and longer time period is required to produce perfectly clean work, as judged by the absence of water-breaks.

Eventually, ware coming from the tank is not being cleaned in the usual length of time needed for the cleaning operation, and then it will be possible to employ the test method to real advantage. If the approach of the critical or breaking point can be detected, the method is of great value.

Suppose, for example, that a five-minute time period is required to clean the sheet in a new solution, and that the time gradually climbs to fifteen minutes. When it requires fifteen minutes to clean the test sheet, bad work starts to come from the tank, and no matter how much is added the activity cannot be restored by further additions of cleaner.

Rinsing Rinsing is a phase of the cleaning operations which should be regarded as important. In fact, without good rinsing, good cleaning will not result in good finished work. The ideal condition would be that of a heavily running hot rinse; or rather than a still hot rinse, a good, fast running cold rinse. As the work comes to the rinse tank, it naturally carries some of the cleaning solution on its surface, and if the cleaner is one which emulsifies the oil on the ware readily, there will be more or less oil carried over on the ware in the form of an emulsion. If the rinse is ice cold, the shock from the sudden drop in temperature will have a tendency to close the pores of the metal and trap some of the cleaning solution in the pores. When the work goes to the acid tank, the pores of the metal are opened by the etching effect of the acid and the imprisoned oil and cleaner are liberated. If there is a soapy film on the ware, it will be broken down by the action of the acid and the soap grease liberated. Such being the case, the work will undoubtedly show water-breaks.

Immerse the basket of ware in the rinse tank, allow it to stand for a moment or so until the washed-off emulsion has had an opportunity to float to the overflow. The results will be better than when the basket is pulled up through the film on the surface of the solution.

Rinsing of a cleaner does not mean rinsing alone. It also includes draining of the cleaner from the ware as it is taken from the cleaning tank. A cleaner which will not drain readily until it is practically all off the ware, will rinse hard as well. It is advisable, therefore, to select a cleaner which drains readily from the metal rather than to depend entirely on the rinsing operation to remove it.

Electrolytic Cleaning Electrolytic cleaning is in common use in the plating industry where a source of direct current is at hand. It would necessarily mean the addition of considerable new equipment, and the amount of work carried in the ordinary basket would draw so much current that it would probably be a rather costly method. It has its merits, however, in speeding up the cleaning action, and it may be that it will finally come into common use. The liberation of the gas at the metal will naturally disrupt the oil film and allow it to be more easily removed by the ordinary action of the cleaning solution and the mechanical action of the boiling solution.

Method of Packing Basket Methods of packing the ware in the cleaning and pickling baskets depend on the type of ware being cleaned. The looser it can be packed the more readily can the

cleaning solution reach the oil and the shorter will be the cleaning time. The solution can drain from a loosely packed basket, and less solution will be carried over into the rinse tank. The additional baskets which will be packed will be more than taken care of by the added advantage of more thorough cleaning and consequently less rejected work.

Cleaning of the steel prior to pickling and enameling deserves serious consideration. Men in charge of the pickle rooms are realizing the importance of the cleaning operations and are thus attempting accurate control.

COWLES DETERGENT COMPANY
7016 EUCLID AVE.
CLEVELAND, OHIO

ACTIVITIES OF THE SOCIETY

OUR NEW OFFICERS

They need no introduction. They are known by their works. Here are their faces and a little about who they are.

Edward Orton, Jr.

The works and activities of General Edward Orton, Jr., have oft been told; a metallurgist, geologist, ceramist, soldier, educator, business executive, and philanthropist. He has for long had leading rôles in educational, business, civic, and army affairs. He is not a politician seeking office; he is a politician who is constantly being sought for official leadership. We have him for our leader this year. He did yeoman work for the first nineteen years of the SOCIETY's existence serving as Secretary and Editor. He has already this year made himself felt in his proposal of a Fellow Member Classification. We shall not go amiss if we follow General Orton, our new President.

EDWARD ORTON, JR.

Paul E. Cox

Professor Paul E. Cox, head of the Department of Ceramic Engineering, Iowa State College, was elected Vice-President of the AMERICAN CERAMIC SOCIETY at the Annual Meeting held in Toronto, Canada. He was a trustee of the SOCIETY for three years and at present he is a member of several committees, including the committee to revise membership classification. He is also the AMERICAN CERAMIC SOCIETY representative to the jury which awards the Binns Medal. This medal is given each year to the man who has consistently done outstanding work in ceramic art.

PAUL E. COX

Professor Cox has recently been honored by the President of the AMERICAN CERAMIC SOCIETY by being named as the representative of the SOCIETY to the American Association for the Advancement of Science.

Professor Cox began his career in his father's stoneware plant at Gas City, Indiana. Before attending college, Prof. Cox had charge of the plant. In 1905 he was graduated from Alfred University, and for several years thereafter he worked at stoneware plants to gain practical knowledge. Professor Cox was made technician at the Newcomb Art Pottery, Newcomb College, New Orleans, in 1910.

During the World War, Prof. Cox was engaged by La Compagnie Générale des Meules, Paris, France, to assist in the construction of an abrasive plant just outside Paris. Such products had not been produced in that locality before. Many difficulties were encountered, but a good volume of quality ware was turned out in due time.

For a short time after Professor Cox returned to the United States he was connected with the Pittsburgh Grinding Wheel Co., of Rochester, Pa.

In 1920 he was made head of the Department of Ceramic Engineering at Iowa State College and since that time has worked wholeheartedly at the task of making his department one of the best in ceramics in the country.

Duane F. Albery, Trustee Representative, Terra Cotta Division

Born in Columbus, Ohio. Columbus Grammar and High Schools. Degree of Ceramic Engineer, Ohio State University, 1909.

DUANE F. ALBERY

Ceramic Engineer, American Terra Cotta & Ceramic Co., 3½ years; Ceramic Engineer, Federal Terra Cotta Co., 6 years; Ceramic Engineer, Assistant Superintendent, and at present, Superintendent, The Northwestern Terra Cotta Company, Chicago, Ill.

Chairman, Terra Cotta Division, AMERICAN CERAMIC SOCIETY, 1926; Chairman, Chicago Section, AMERICAN CERAMIC SOCIETY, 1928; CHAIRMAN, American Ceramic Exposition, held in conjunction with AMERICAN CERAMIC SOCIETY meeting in Chicago, February, 1929.

Henry C. Kleymeyer, Trustee Representative, Heavy Clay Products Division

Henry C. Kleymeyer was born in Henderson, Ky., where his father operated a hand brick yard.

By the time he was fourteen years old he had the experience of taking part in manufacturing common hand-made brick as an off-bearer and in the manufacture of face brick he was an off-bearer, making re-pressed brick similar to the Philadelphia re-pressed brick. He also had experience in manufacturing drain tile of the old horse shoe shape by having the job of pushing off-bearing boards under the machine to catch the tile as they came out of the die made by a horse power plunger tile machine.

HENRY C. KLEYMEYER

He graduated through the brick and tile business, working in all of the departments from the clay pit to firing the kilns and from there into the office where he became bookkeeper and salesman.

In 1895 in connection with his father, H. Kleymeyer and F. Klutey of Henderson, Ky., he moved to Evansville, Ind., and organized the First Ave. Brick & Tile Co., manufacturing soft-mud brick in an open rack and pallet yard, and also drain tile, drying them in a steam pipe drier.

In 1903 he organized the Standard Brick Mfg. Co., buying out two soft-mud plants, one located on the east side of Evansville and the other on the west side. After a short time the west side plant was converted from a soft-mud to a dry-press plant, using shale instead of surface clay. This outfit operated for ten years when another change was made, from the dry-press to the stiff-mud system, drying the brick in a waste-heat drier, firing them in a Haigh

continuous kiln. Later the round downdraft kilns were added, first firing with direct-coal firing and later with the Underwood system of producer-gas firing.

In 1911 Mr. Kleymeyer and his associates bought out a small soft-mud plant at West Point, Ky., which was remodeled to the stiff-mud system, firing the brick in downdraft kilns, which are now being fired with natural gas.

At this time Mr. Kleymeyer is in direct charge of three plants at Evansville, Ind., two operated by the Standard Brick Mfg. Co. and one by the First Ave. Brick & Tile Co. Two other plants are under his development management, the Southern Brick & Tile Co., at Louisville, Ky., and the West Point Brick Co., West Point, Ky.

His official titles are President and General Manager, Standard Brick Mfg. Co., Evansville, Ind.; Secretary-Treasurer, First Ave. Brick & Tile Co., Evansville, Ind.; President, West Point Brick Co., West Point, Ky.; and Vice-President, Southern Brick & Tile Co., Louisville, Ky.

He also serves as director in the following organizations: Old National Bank Imperial Desk Company, Regal Furniture Company, Sunbeam Electric Company, and Southern Ind. Gas & Electric Co., all in Evansville, Ind., and Kleymeyer Klutey Brick & Tile Works, and Marstall Furniture Co., of Henderson, Ky.

At present he is serving the following civic and professional organizations in an official capacity: President, National Brick Manufacturers Association; Trustee, Evansville College; and Treasurer and Director, Y. M. C. A. in Evansville.

In the past he has served as director of the Building Brick Assn. (the pioneer association for brick sales promotion); director of the American Face Brick Assn., vice-president and director of the Common Brick Mfrs. Assn., director of the Indiana Manufacturers Assn., director of the Indiana State Chamber of Commerce, vice-president of the Ohio Valley Improvement Association, and president for two terms of the Evansville Chamber of Commerce.

OUR TORONTO MEETING

In Toronto, in the Royal York Hotel, the week of February 16, 1930, this SOCIETY had its Thirty-Second Annual Meeting. That is a simple statement of fact. If that simple statement was amplified with all the superlative adjectives and phrases to be found in the many letters and two telegrams of congratulation received in this office it would not be too extravagant and vainglorious. That Meeting was all that could well be said in praise of it.

The programs were excellent, thanks to the Division program committees. The entertainment was just right, thanks to the good taste and conscientious personnel of the Local Committee. The weather was most perfect; all that we wished it to be. The hotel and its efficient staff were ideal.

It is impossible to give personal credit to all who made that Meeting so nearly 100% perfect but we would be failing in faith to the nearly 1100 registrants if we did not record the geniality and democracy of that great engineer, scientist, artist, soldier, educator, and executive, General C. H. Mitchell, Chairman of the Local Committee. He is a man's man, a ladies' man, a scholar's man, and a boy's man. He was there with hearty good will and wise council. As chief of the Local Committee he measured the full length of our ideal.

And Harold F. Dingledine, quiet, unobtrusive, back-stage sort of an executive, was always alert to see that every Local Committeeman functioned. As Vice-Chairman, he was doubly good, for his wife did team work with him.

Mr. and Mrs. Ryland New; tireless, courteous, regular Mr. and Mrs. Fixits. Smiles never ceasing, bodies never wearying, minds ever active, all for the single purpose of seeing that everyone was where he most wished to be and had that which he most desired.

And those big fellows, Albert U. Coté, and W. J. Nicholson and many other Canadian members of our SOCIETY were there with heads, hands, feet, and purse just for each of us. Those of us who saw them in action know that they were doing a lot to make things go so smoothly.

Dr. A. E. R. Westman and his lantern and movie camera gang were always on schedule with screens and lanterns just as wanted. They performed perfectly; the best ever.

And are we forgetting that genial Gordon C. Keith, Secretary and Treasurer of the

ALBERT U. COTÉ

A. E. R. WESTMAN

HOWELLS FRÉCHETTE

Local Committee? Not for a moment. We could not. He was very impressive as befits an efficient secretary, sleeping little and working always.

Howells Fréchette, the enterprising director of the Ceramic Division of the Ontario Department of Mines was the busybody who assembled the Canadian exhibit that was on the Convention Mezzanine. He also, as Secretary of the Heavy Clay Products Division, made the program of that Division snap along. He is Chairman of the Heavy Clay Products Division for 1930.

So much for those who made the wheels go around.

We wish that we could show a picture of each and every one who contributed to making the programs the best ever. They are our best workers and thinkers.

Four new features were successfully inaugurated: (1) a practical ceramic art program of industrial coöperation, (2) management meetings, (3) noon-day luncheons, and (4) factory processing discussions.

Toronto will be remembered truly as a "Meeting Place" much worthwhile.

REPORT OF COMMITTEE ON CLASSIFICATION OF MEMBERSHIP

BY EDWARD ORTON, JR., *Chairman*

This committee was appointed several months ago by Mr. Bole, your president, with

the urgent request that it should consider its task very carefully and report at this Meeting. The members of this Committee are the following:

Edward Orton, Jr., Past-Secretary, *Chairman*
Lawrence E. Barringer, Past-President
Albert V. Bleininger, Past-President
M. C. Booze, Past-President
Paul E. Cox, Vice-President
A. F. Greaves-Walker, Past-President
Robert L. Landrum, Past-President
Roy H. Minton, Past-President
Forrest K. Pence, Past-President
Frank H. Riddle, Past-President
Homer F. Staley, Past-President

Of the total membership of eleven, eight are present and they have considered this report and have agreed to it unanimously. The other three men have wired that they cannot be present.

Scope of the Work

The subject of this work is perhaps not fully described by the title "Classification of Membership." It will be perhaps advisable, before presenting the recommendations of the Committee, to explain or review briefly the situation with which we have attempted to deal. What are the things which lead to the formation or the perpetuation of scientific, technical, or professional societies?

As I analyze it, there are three principal purposes back of the formation of any technical society. Ordinarily, all three of these motives, or underlying reasons, affect each other, although they are perhaps not all equally stressed by each organization. No matter how they start, such organizations ultimately come to recognize these three things.

The first motive is the desire of the members to help themselves. Self-interest is deeply embedded in all of us. If it were not, we probably would have faded out of the picture and become prehistoric animals along with thousands of others who have flitted across the screen of the world's history. Although we have to be selfish in order to live and hold our places in the struggle for existence, we also have to be unselfish in order to progress and live better. The primary thing, then, which starts these societies is a selfish desire on the part of all of us to gain something, thereby helping ourselves.

The second motive is something which follows the first, namely, to promote the science, industry, or the profession which we happen to represent.

The third motive, which comes still later, but which must come ultimately, is to help the public or society in general.

Purposes of Technical Societies

The first purpose is usually the uppermost one. The general desire is to get better and more complete knowledge of our work. The more knowledge a man acquires, the more acutely does he feel the gaps in his knowledge, and the immense open spaces in which his mind has not penetrated, and into which he realizes that his whole life work will enable him to penetrate but a very short distance. He knows that no one can possibly know exactly what he knows, but he also knows that everybody else knows things which he does not know; and, therefore, the necessity of exchange is a practical matter. Everyone must expect to exchange knowledge and to gain through others by contact with them, the things which he himself lacks. Similarly, he must impart to others, by free exchange, the things which he has. This is the foundation of all scientific growth and the purpose of all technical organizations.

Secondly, apart from this simple, selfish, elemental, and entirely proper ambition to grow as a scientist or professional man and thereby to gain more knowledge, reputation, power, money, or whatever it is he is striving for, there is sure to come a constantly and growing recognition of another principle, *viz.*, that the science, industry, or profession must also grow and make progress. If his industry or profession is static, unprogressive, or self-satisfied, it is going to hold him back. Hence, no matter how selfish a man may be, he must come to realize that he must help his group as a whole, or be held back by his group. Most men in our plane of life readily realize this truth. Even the less group-minded members of a society become less selfish and more imbued with the love of their profession, and more filled with a desire to advance it, as they continue to work in the program of that society. Such societies are certain to develop a high esprit de corps, a common united desire to hold high their heads, and to do what they can to advance it. That is one of the great things which justifies the existence of such organizations.

Thirdly, we all come to realize as we attain more maturity, the close inter-relation of all human activities. We gradually come to see, through our labors to develop ourselves and our science, that all men are profiting, that living is becoming steadily safer, better, and happier. The full realization of this principle is the thing we should strive to attain. It is the thing which adds dignity and self-respect to what might be a purely selfish struggle for life.

Taking up next the question of the various modes of organization of technical societies, some of the organizations are simple, others have much more elaboration, while many of them begin simply and become more elaborate as their experience widens. It is of interest to observe the marked similarity which in time develops in all of them. This similarity cannot be ascribed to mere imitativeness. Individuality is a strong counter-force. The real reason that they become alike or similar, is that the same forces operate in all of them, and hold all of them in their iron-bound control. Efficiency and success require much the same procedure in all of them. They cannot get very far apart in their methods of operation if they are to succeed.

Typical Membership Classifications

The essential thing in any society is its membership. The membership is the real basis of everything. No society can maintain high ideals, if its members hold low ideals. Therefore, it is from the study of the membership that one discovers the essential unity of organizations.

In practically all technical societies, three groups of members have been found necessary. First, a mature or fully developed group, which constitutes the backbone of the society, the vital part of the organization. Secondly, a less developed group, growing up and aspiring to become mature, and thirdly, a small group of the sages or the wise men, who have arisen to great eminence by reason of their achievements.

The names by which these groups are called, naturally vary somewhat but the commonest terminology is members, associates, and honorary members. The members are the backbone. The associates or juniors are the young fellows who are growing up, hoping to become members. The honorary group in nearly all societies is quite strictly limited in number. For instance, the AMERICAN CERAMIC SOCIETY has a nominal limit of ten honorary members, but we have never had more than four at any time, and I believe that there are only two now. We have never made light of the value of this title of honorary membership in recognition of the great names in present-day ceramic progress.

Your Committee has studied the organization of some twenty-five such societies. We have examined most of the strong scientific and professional engineering societies in the country. A circular letter was sent out requesting data from a considerable group. There were about thirty replies out of the forty requests.

Two Principal Groups

Studying these answers closely, they can be divided into two groups. Both groups have members, an associate or equivalent grade, and honorary members, but in the first group, the member grade is subdivided into two classes, while in the second group it is not.

In the first group, the members are classified into (*a*) Fellows, or some similar name, comprising the best trained or the most experienced, and (*b*) Members, or some similar name, comprising a group of somewhat less trained or experienced men. Both of these groups vote and are superior to the associate or junior grade, although, of course, both of them are inferior to the honorary group. The point stressed here is that there are two gradations within the membership when they have attained a professional status. There are about ten societies in which this classification of members prevails.

In the second group the membership grade is not subdivided. The members vote and the associates do not. There is, however, a very important thing to be noted in this connection. In this whole group, the qualifications for membership have been placed so high, initially, that anyone who can qualify to become a member is potentially a person to be entrusted with a vote. That is, in this second group of societies, they establish but one grade of membership.

There is a third group consisting of only two societies, in which the member grade is not subdivided and in which the members vote and the associates do not; in this group the qualifications for membership are nominal only. They can be met by all. The difference between members and associates therefore practically disappears. Membership depends only upon the payment of dues or duration of period of membership. The two societies representing this group are the AMERICAN CERAMIC SOCIETY and the American Chemical Society.

The American Chemical Society is one of the strongest organizations in the country. It has a very large membership, something over 20,000. I must explain in regard to that organization, that, because of the peculiarity of its mode of organization, there have outgrown from it two advanced chemical societies, both of which require very stiff qualifications for membership. While the vast majority of all chemists belong to the American Chemical Society, they do not gain any professional standing from that fact, because anybody can join. If they wish professional standing, they must gain admittance to the Institute of Chemical Engineers or the Institute of Chemists. Either one is a high-grade technical organization with stiff entrance requirements. Thus, in effect, the American Chemical Society, by the mode of its organization, has brought about the same situation for aspiring chemists as prevails in the large groups discussed above.

Our Anomalous Position

This leaves the AMERICAN CERAMIC SOCIETY alone in a very anomalous position. We are the only important society in the country, so far as the studies of this Committee have gone, which makes admission extremely easy, and which at the same time gives no recognition to professional skill or scientific attainment.

Going back to the history of our organization, it is appropriate to point out that at the time of its organization we established the honorary grade, the active membership grade, and the associate grade. At this first meeting there were twenty-one persons who had been invited to come together to found this SOCIETY. All of these men became active members. One associate member was elected at this meeting.

This policy of active membership with high qualifications and an associate membership with easier qualifications started when the SOCIETY started It was carried on for some twenty-four years. In 1923, constitutional changes were adopted, by which the meaning of the term, "Active Member," was made different by admitting anyone

who would pay dues for two years. To be exact, anyone was admitted as an Associate Member and after payment of dues for two years automatically became an Active Member.

Gains vs. Losses

Your Committee has no desire or disposition to dispute the wisdom of this change. We have no desire to say that it has not accomplished a great deal of good. That the SOCIETY has since gained tremendously in numbers, in income, in power to serve the industry, is beyond all contradiction. On the other hand, the SOCIETY, according to our view, has lost certain things which it used to have. In the first place it has lost its appeal to the personal ambition of its members. I mentioned earlier this old trait of human selfishness that is in us. Personal ambition is one of the mainsprings which actuates all normal humanity, and in removing this spur, this SOCIETY has lost a powerful appeal to the personal ambition of its membership.

Formerly, Associates had to work, and work hard, to win memberships. They had to write papers, to make discoveries, work on SOCIETY committees, or become noted as plant managers or executives. In short, they had to *arrive*, in some way and in some part of the field; otherwise they could not become Active Members. Now with this spur to personal ambition gone, many members who could and who should do a great deal for the SOCIETY, do not do anything, because they can get the nominal fruits of membership, without doing any work whatever.

Another point. The SOCIETY has lost its leadership over the rising generation. In the older days, in every school that was teaching ceramics, it was held up constantly to the boys, "Now, you can get to be a member of that SOCIETY if you do something," and their minds were set early on that goal. They would begin research in college and extend that work as soon as they got through, all with a hope of beginning to get their feet firmly planted on the ladder and beginning to climb. We cannot offer that appeal any longer. The boys know the situation. It used to be a powerful lever to stimulate the ambition of the younger fellows who had not yet come in. It is not now.

The SOCIETY has also lost standing among other professional societies. I do not want to be misunderstood about this. Other societies recognize that the AMERICAN CERAMIC SOCIETY has done a wonderful job. We have created a literature in kind and quality and amount, second to none, considering the limited period of thirty-two years in which we have been operating, and they give us credit for that fact. But they all recognize the fact that membership as such, does not mean anything in this organization. They believe in the SOCIETY as having done a good work, but they do not believe that membership in the SOCIETY is any criterion of quality in the individual at all.

I have tried to paint for you in these preliminary remarks, the general picture or situation, as the Committee has viewed it. We have met three times. We have spent hours in discussion on each occasion. Each man on the Committee is well qualified by years of experience, in the SOCIETY and out of it, to know the field pretty well. The Committee has unanimously agreed upon the following ten recommendations, which I now present to you. The Committee is a unit in believing that the SOCIETY should take action to change its Constitution to enable it to retrieve the ground which it has lost, and also to begin again to build up the strength which it can easily attain.

Recommendations of the Committee

(1) That a new grade of membership should be established to be called the Fellowship. An individual member would be called a Fellow. Elevation to this grade shall be based upon recognition of professional accomplishments in the sciences or in the practical arts, and upon work done in and for the SOCIETY.

(2) That there shall be no change of a member's political status in the SOCIETY by reason of this recognition.

(3) That any member may aspire to win the honor of Fellowship if he can qualify to meet the requirements.

EXPLANATION: In this way, a certain standard will be set up and any man who can meet the standard can get in. It would not make any difference what Division he works in, or whether that Division had a large or a small number of Fellows in it.

(4) That the dues to be paid by Fellows shall be $5.00 a year higher than Active Members.

EXPLANATION: This provision is to provide funds for the increased expenses to maintain this extra group. This point was debated arduously by the Committee. Some said, "Why penalize a man who has attained eminence by making him pay more?" The answer is clear. In order to give a man this honor, it would be necessary to give a certificate; to set up a very carefully administered method of getting information about a candidate, all of which would mean added expenditure to the SOCIETY. Therefore, the men honored should be willing to pay an increase in dues to cover the expenses thereby created.

(5) That all Charter Members of the SOCIETY, who are still members of the SOCIETY, shall be constituted into an organizing committee, to select the first one hundred Fellows on their records of achievement.

EXPLANATION: There were twenty-one Charter Members; they are not all alive and they are not all active in the SOCIETY. There would probably be from twelve to fifteen men on this organizing committee who would be the first jury to pass on the eligibility of men for Fellowship. Apparently no fairer or more conservative body could be selected to perform such a task. They would be practically certain to select all the men who are still members of the SOCIETY, who won their place as Active Members under the old requirements, and as many more of the most outstanding men of mature years, as the limit of one hundred would accommodate. Under no circumstances could they begin to cover the active list of high-grade productive men who now belong to the SOCIETY.

(6) That the first one hundred Fellows thus selected shall organize and establish the requirements for future elevation to the grade.

EXPLANATION: The rules and requirements by which Fellowship shall be conferred in the future will be determined by the first one hundred selected; that group in turn to be selected by the Charter Members. It is difficult to imagine the Charter Members being other than cautious and conservative in the matter of the selection of the first outstanding one hundred men. It is also difficult to imagine the one hundred men thus designated doing anything unfair or arbitrary, in laying down the broad, general rules for qualifications on which all future promotions would depend.

(7) That certain work, which is not now being done, or which receives little attention, shall be assigned to be done by the Fellows for the SOCIETY.

EXPLANATION: There is no portion or organization in the SOCIETY at present which acts as a Senate, or general unifying influence. The Board of Trustees has naturally and necessarily become primarily a business organization and does not, and cannot, do much more than handle the business affairs and general policy. The seven Divisions, and more may be formed as time passes, are each, in effect, a society in themselves, but their interests are so diverse, and the men in different Divisions are so little acquainted with each other, that they make more for cleavage than unity in the SOCIETY. A unifying influence is needed to hold it together and strengthen it at the top. The creation of a group of Fellows, selected without regard to divisional affiliations at all and without regard to any political considerations, would give just exactly the cohesion that is needed.

To such a group should be submitted, for instance, such questions as professional ethics. This question comes up in every organization. Thus far, mercifully, we have not had much occasion to go into questions of professional ethics, but it is idle to assume

that such questions will not arise from time to time. The Fellows could very properly be given the task of discussing such cases, perhaps the laying down of a code of ethics.

Again, there are certain inter-division relationships, where one Division may start out on a course of action, which seems to it perfectly proper, and of which some other Division might take the opposite view. There should be a place where such inter-relationships can be debated in a nonpartisan spirit. There are certain questions which come before the Board of Trustees, which they recognize to be of importance, but which they do not have full time to examine into, or to debate at length. There should be a place where such questions can be reviewed in a more leisurely fashion.

(8) That, in general, the Fellows shall act as an Advisory Committee to the Board of Trustees, concerning themselves with matters affecting the general good of the SOCIETY, and shall not have Executive functions except in the matter of determining their own membership. They shall not invade the technical fields of the Divisions, or the Standing Committees, or reduce in any way the official responsibility of the Board of Trustees.

Constitutional Amendments[1]

In order to make the above list of recommendations possible of execution, it is necessary to amend the Constitution. The Committee was not charged with the matter of preparing these constitutional changes, but it was believed that the most effective way to help the SOCIETY to make progress in the matter was to prepare the necessary constitutional amendments and submit them as a part of the report so that when this matter has been acted upon, after due debate, it can be referred to the Committee on Rules, and after they have acted upon it, it can take the usual course of voting by letter ballot of the membership. The constitutional changes cannot be voted upon at this Meeting, but the principle of the idea can be approved leaving final action to be taken in the way for which the Constitution provides.

As before stated, the SOCIETY cannot at this time take action upon the proposed amendments to the Rules. It can, and in my opinion, should at this time discuss the recommendations of the Committee, in which the plan of creating the Fellowship grade of members is set forth, and if it approves the plan, it should adopt the same in principle, leaving to the Committee on Rules and the Executive office, the further steps of making the provisions effective. It goes without saying that the Committee on Rules would not be likely to submit the amendments to letter ballot, if the vote of the SOCIETY at this time on the general principles involved were strongly adverse.

For the purpose of bringing the matter definitely before you for action, I make the following motion:

That the SOCIETY approve in principle the program submitted by the Committee and refer the constitutional changes to the Committee on Rules.

DR. SILVERMAN: In seconding the motion, I would like to express a reason for it. I well recall that some twenty-five years ago, the gentleman who has just proposed these changes came and asked me for a paper. I was a youngster, and the Meeting happened to be held in Pittsburgh. It was on strength of his stimulation that I gave him a paper on that occasion, and that I became an Associate Member of the SOCIETY. It was made clear to all of us at that time that the thing to which we should all aspire was Active Membership, and it was just that stimulus that prompted many of us to get into the field of research and investigation, and to have the credit of being Active Members in the SOCIETY.

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[1] For the text of the "Amendments to the Constitution and By-Laws" see *Bull. Amer. Ceram. Soc.*, 9 [3], 71–74 (1930).

There is so much in this progressive report that is of real value to the AMERICAN CERAMIC SOCIETY, a report that to me at least seems one of the most complete that has ever been published, that I, therefore, take pleasure in seconding General Orton's motion.

MR. POTTS: Mr. President, I also want to second this motion. I submitted my first paper about 1910, and a few years later I submitted other papers, and it was one of the proudest days of my life when I was nominated for Active Membership. On the other hand, I felt that I had lost something some ten years later when I took up a list of membership of the AMERICAN CERAMIC SOCIETY and saw on there the names of men whom I knew had never done any research. But it has been a feeling of considerable gratification to me to know that this move has at last been started. If we can establish this grade, it makes no difference what we call it, and stir up in the young fellows, and the old fellows, the desire to arrive, then certainly we are going to make it easier for the Secretaries of the Divisions to get something that is worth while, and we are going to improve our literature.

THE PRESIDENT: If there is no further discussion, I shall put the question.

The vote being then taken, the result was unanimously affirmative, and the President declared that the motion was unanimously carried.

MINUTES OF MEETING OF COMMITTEE ON AWARDS

The Meeting was called to order Monday, February 17, at 2:30 P.M. at the Royal York Hotel, Toronto, by Chairman Helser.

Members of the Committee present were: Messrs. Silverman, Parmelee, Staley, Baggs, and Trostel.

The first item discussed was the type of paper for which the award was to be made. The Committee decided that the award should be limited to papers constituting an original contribution which had been accepted by the SOCIETY and published in the *Journal*. It was suggested that the Board of Trustees later make provision for a type of award not covered by the above case. This second type of award being of the sort generally referred to as "meritorious service."

The second topic discussed was the question of limitations as to the persons who might receive this award. It was decided that neither sex nor nationality should be a bar. It would be necessary, however, that the author of the paper be a member of the SOCIETY. In the case of multiple authorship, separate medals may be awarded to each co-author.

Third, the only papers to be considered as being eligible for the award are to be such papers as have been published during the calendar year prior to the Annual Meeting at which the award is to be made. The Committee felt, however, that any paper which had been submitted to the *Journal* and was found too expensive to be printed but which was of especial merit should be referred to the Committee on Awards for their consideration.

Fourth, the award of the medal each year, in each Division, is not mandatory. This point was discussed in some detail and resulted in a motion by Mr. Staley, seconded by Prof. Parmelee, that one medal may be awarded in each Division once in three years for an original contribution which has been published in the *Journal*. The first three-year period is to start from January 1, 1930. The meaning of the word "original" was conceived to mean original in conception and not heretofore presented elsewhere in any other Journal.

The Motion was carried.

Fifth. The question of divisional juries was discussed and it was finally decided that such juries shall be chosen by the Fellows of the Division acting as a Committee. In the event that the Fellowship Plan should not mature the Awards Committee will make further recommendations.

Sixth. It was decided that a certificate of award should accompany the medal.

Seventh. The design of the medal was discussed in detail. It was the feeling of the Committee that the medal should be a large bronze one, about two and eleven-sixteenth inches in diameter similar to the Garden Club sample submitted by the Medallion Art Company of New York City. The Committee plans to have on display at the next Annual Meeting, in Cleveland, the completed medal. Professor Baggs suggested as sculptor, Mr. Frey of the Ohio State University. Professor Baggs will handle the question of design through Mr. Frey.

The Committee decided that the medal shall be named "The Orton Medal of the AMERICAN CERAMIC SOCIETY." The medal to bear on its front face, an appropriate bas-relief of General Orton. The reverse side of the medal will be suitably stamped or engraved to show the divisional medalist and the year of award.

Eighth. The question of financing the medal was given consideration and from estimates on hand it appears that a fund of $2000.00 would not only care for the initial financing of the cost of sculptor's fees and die-plates but would also provide an endowment fund to yield about $50.00 a year which would care for the cost of striking off new medals. Actually, only about $1000.00 is needed to start the proposition and $50.00 per annum thereafter. The Committee expressed its willingness to coöperate further with the Board of Trustees to help raise the initial fund necessary to insure the success of the project.

REPORT OF STANDARDS COMMITTEE, AMERICAN CERAMIC SOCIETY, FEBRUARY 19, 1930

During the past fiscal year this Committee has decided the following points:

(1) Any revision of a Standard of this SOCIETY, after approval of the Standards Committee, shall appear appended to the Standard as a note marked "Tentative Revision" and shall stand as such until the SOCIETY by the prescribed procedure shall change the Standard to correspond with the revision.

(2) Rewording of any Standard which serves only to clarify, shall, when approved by the Standards Committee, be immediately operative.

(3) Items (1) and (2) must originate in the Section first introducing the Standard unless the matter is of interest to more than one Section in which case all Sections concerned shall approve any change proposed before it can be considered by the Standards Committee.

(4) Items (1), (2), and (3) respectfully referred to the Rules Committee.

(5) Symbols for Heat and Thermodynamics to be changed as per revised publication of the American Standards Association.

(6) Symbols for Mechanics, Structural Engineering, and Testing Materials shall appear in the *Bulletin* of the SOCIETY and in the next issue of the Book of Standards.

(7) Mathematical symbols as approved by the American Engineering Standards Committee shall appear in the *Bulletin* of the SOCIETY and in the next issue of the Book of Standards.

(8) Definitions of Spalling as approved by Committee C8 A.S.T.M. shall become tentative in the AMERICAN CERAMIC SOCIETY.

(9) Definitions of P. C. E. as approved by Committee C8 A.S.T.M. shall become tentative in the AMERICAN CERAMIC SOCIETY.

(10) In all standards and tentative standards and other publications of the AMERICAN CERAMIC SOCIETY, the term "fired" shall replace the term "burned" in all matters dealing with clays and other non-combustible materials.

(11) Specifications for vitrified china, classification of pottery and whiteware, and classification of electric porcelain, all referred to the White Wares Division for consideration.

Respectfully submitted,
Standards Committee
ARTHUR S. WATTS, *Chairman*

COMMITTEE ON GEOLOGICAL SURVEYS, AMERICAN CERAMIC SOCIETY

For the coming year the Committee can start in and work to the best advantage on the suggestions made last year, namely, the stimulation and securing of papers for the Annual Meeting and for publication in the *Journal*, and encouraging and fostering more work by the State Geological Surveys and Federal Bureaus.

There is another line of work in which the Committee could be particularly useful. What I have in mind is the abstracting of articles relating to the geology of ceramic materials for *Ceramic Abstracts*. The Committee could divide up the principal publications that are available, and each member agree to abstract articles appearing in the publications assigned to him. In this way, the Committee could pretty thoroughly cover the entire field.

An outline of some of the work done and items of interest reported by members of the Committee during the past year are as follows:

Professor Hewitt Wilson reports that he has interested some University of Washington geologists in different ceramic problems in the state of Washington. Also, the Seattle branch of the Bureau of Mines has been at work on a paper on "Clay." He reports further that owing to coöperation of the Washington State Geological Survey, the Idaho Bureau of Mines, and the United States Bureau of Mines, the following publications to date on clays and allied ceramic materials have been issued:

Solon Shedd, "The Clays of the State of Washington," State College of Washington, Pullman (1910).

Hewitt Wilson, "The Clays and Shales of Washington," Eng. Expt. Station, Univ. of Wash., *Bull.* No. 18 (1923).

F. H. Skeels and Hewitt Wilson, "A Preliminary Report of the Clays of Idaho," Bur. Mines and Geology of Idaho, *Bull.*, No. 2 (1920).

T. O. Smith, "The Puget Sound Shales and Glacial Clays," *Jour. Amer. Ceram. Soc.*, **8**, 849–52 (1925).

Hewitt Wilson, A. L. Bennett, Fred T. Heath, "A Preliminary Report of the Residual Kaolin and Feldspar of the P. N. W.," *Jour. Amer. Ceram. Soc.*, **6**, 475 (1923).

Hewitt Wilson, "Some Feldspathic Materials of the P. N. W.," Bur. of Mines, *Reports of Invest.*, Serial No. 2794 (1927).

G. E. Goodspeed and A. A. Weymouth, "Mineral Constituents and Origin of a Certain Kaolin Deposit near Spokane, Wash.," *Jour. Amer. Ceram. Soc.*, **11**, 687–95 (1928).

Hewitt Wilson, "Ochers and Mineral Pigments of the P. N. W.," Bur. Mines, *Bull.*, No. 304 (1929).

Hewitt Wilson is also working on a Bureau of Mines report on kaolins and whiteware materials of the Pacific Northwest, and plans to complete this during the latter part of 1930.

G. R. Shelton, formerly of North Carolina State College, reported that he had been interested in testing ceramic materials in North Carolina, and in the late spring was engaged in work on pyrophyllite, volcanic ash and talc, and in collaboration with Dr. Stuckey, Professor of Geology, was working on a plan to connect, as closely as

possible, the mineralogical, geological, and ceramic data on these materials. This work is said to be in progress.

Raymond B. Ladoo reports that he has been working on a treatise on pottery plaster for the White Wares Committee. While this is not geological work, it is of interest in showing the activities of the committee members.

John W. Whittemore, of Virginia Polytechnic Institute, reports that a survey of the raw ceramic materials is in progress, which will be published in bulletin form. He also reports that S. L. Galpin, of the geology department of the University of West Virginia, is planning a similar survey for West Virginia. Professor Whittemore, during 1928 assisted in a very complete survey of the clay resources of Louisiana. The report of this survey has been published in bulletin form, and may be secured from the Louisiana Conservation Commission, Minerals Division, Shreveport, La.

In answer to a letter of inquiry to Walter B. Jones, State Geologist, State of Alabama, he reports that the Geological Survey of Alabama, coöperating with the Department of Ceramics recently established at the University of Alabama, is beginning an investigation of the ceramic resources of the State. It is planned to publish a preliminary report on a large number of samples, followed by a separate report on special types of materials, as soon as the work can be completed.

Your Chairman has been working with George C. Branner, State Geologist of Arkansas, on a proposed plan for a survey of Arkansas clay resources. Details of the financing of this survey have not been worked out, and it has not been decided whether or not it will take place.

The State Geological Survey of Missouri has been active during the past year in the study of ceramic materials in Missouri. H. S. McQueen, Assistant State Geologist, devotes a large part of his time to this work, and very probably bulletins on this work will appear in the future.

W. M. WEIGEL, *Chairman*
Committee on Geological Surveys

REPORT OF COMMITTEE ON EDUCATION

We are pleased to submit herewith the report of the Committee on Education, AMERICAN CERAMIC SOCIETY, for the year 1929–1930:

For the past two years the Committee has been considering two questions as follows:

(1) Establishment of adequate curricula in ceramic schools for students desiring to become enamel technologists or glass technologists.
(2) Strengthening the curricula of ceramic education in general by increasing the proportion of fundamental sciences and cultural subjects.

In order to bring some of the various questions to an issue, the Committee has passed resolutions, as follows:

I. *Resolved:* That the Committee on Education of the AMERICAN CERAMIC SOCIETY does hereby recommend to the various departments of ceramic education in the United States and Canada that every curriculum in ceramic engineering or ceramic technology should contain, as a minimum, 40% of the total credit hours in the fundamental sciences.

II. *Resolved:* That the Committee on Education of the AMERICAN CERAMIC SOCIETY does hereby recommend to the various departments of ceramic education in the United States and Canada that every curriculum in ceramic engineering or ceramic technology should contain, as a minimum, 15% of the total credit hours in cultural subjects.

III. *Resolved:* That the Committee on Education of the AMERICAN CERAMIC SOCIETY does hereby recommend to the various departments of ceramic education in the United States and Canada that every curriculum in ceramic engineering or ceramic technology should contain, as a minimum, 8% of the total credit hours in subjects dealing with business and management.

IV. *Resolved:* That the Committee on Education of the AMERICAN CERAMIC SOCIETY does hereby recommend to the various departments of ceramic education in the United States and Canada that instruction in ceramic technology in four year curricula be, when possible, confined to the technology of clay products (including special bodies and special refractories), or, the technology of enameled ware or the technology of glass.

V. *Resolved:* That the Committee on Education of the AMERICAN CERAMIC SOCIETY does hereby recommend to the various departments of ceramic education in the United States and Canada that schools wishing to offer instruction in one curriculum in more than one of these three main divisions of ceramic technology extend the length of the curriculum to at least five years.

VI. *Resolved:* That the Committee on Education of the AMERICAN CERAMIC SOCIETY does hereby recommend to the various departments of ceramic education in the United States and Canada that no course in enameling technology be offered unless courses in foundry practice and metallurgy of iron and steel are given as prerequisites or concomitants.

VII. *Resolved:* That the foregoing six resolutions are to be considered as tentative recommendations and are to be submitted to the ceramic schools for discussion and revision during the next twelve months, and will be brought up for final action at the next Annual Meeting of the SOCIETY.

Respectfully submitted,

G. H. BROWN, *Chairman,*

AMERICAN CERAMIC SOCIETY, Committee on Education
A. E. BAGGS
J. C. HOSTETTER
M. E. HOLMES
G. M. TUCKER
A. V. BLEININGER
H. F. STALEY
A. E. MACGEE

BUSINESS MEETING OF AMERICAN REFRACTORIES INSTITUTE DIVISION, AMERICAN CERAMIC SOCIETY[1]

The meeting was conducted by E. H. Van Schoick, Chairman of the Division.

Election of Officers The Nominating Committee having presented a list of nominations for officers of the Division during 1930, and this list having been regularly published in the *Bulletin* prior to the Meeting, the following officers were elected, on motion made by F. A. Harvey, duly seconded, and carried.

Chairman	C. F. Geiger
Vice Chairman	S. S. Cole
Secretary-Treasurer	Dorothy Texter
Nominating Committee	G. A. Bole (Chairman) E. H. Van Schoick

Reports of Committees

Research R. A. Heindl, Division Representative to the General Committee on Research, reported that this Committee has been inactive during the past year.

Data A. E. R. Westman, Division Representative to the General Committee on Data reported that this committee has been inactive, and in view of this inactivity, Dr. Westman questioned whether it is worth while to continue with such a committee.

Education M. E. Holmes, Chairman of the Committee on Education, had no report to make.

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[1] Held Wednesday Afternoon, February 19, 1930, Toronto, Ont.

Membership J. L. Crawford, Chairman of the Membership Committee, reported that the Division now has 618 individual members and 41 corporation members, or a total of 659 members; and that the membership during the past year showed a material increase due to the federation of the American Refractories Institute and the Refractories Division, this alone accounting for 99 new members.

Standardization of Products C. E. Bales, Chairman of the Committee on Standardization of Products, made the following report:

Since the Book of Standards was published, in June, 1928, new material is constantly being accumulated, some of which will be published in the *Bulletin of the American Ceramic Society*, and subsequently to be published in the Book of Standards.

Standardization of Tests The Chairman of the Committee on Standardization of Tests, Stuart M. Phelps, reported that the committee had been inactive.

On motion by L. C. Hewitt, duly seconded and carried, the above Committee reports were accepted for file.

Rules The Rules Committee, of which Donald W. Ross is Chairman, presented the following changes to the By-Laws of the Refractories Division.[1]

Page 63, line 3 following the word "chairman" insert, "the Division Trustee."

Page 63, next to the last line following "Membership Committee" insert, "a Division Publications Committee, a Division Research Committee."

Page 63, next to last line following "turn," insert "each," following "select," change "their own" to "two."

Last line following "Members" change "." to "," and add the following: "who shall be subject to approval by the Division chairman. Any of these committees may be enlarged for the fiscal year, at the discretion of the Executive Committee."

The duties of the Publication Committee shall be to read and edit or reject all papers hereafter intended to be presented before the Division, and all other papers on refractories submitted for publication in the *Journal*.

The duties of the Research Committee shall be to familiarize itself with researches which are being conducted on refractories, and to determine what additional researches might be expected to yield results that would advance the art. The further duties of this Committee shall be to endeavor to prevent duplication of researches on refractories, to promote coöperation between those who are conducting researches which are of like nature to refractories, and to suggest researches on refractories to those desiring such information. The chairman of the Research Committee of the parent SOCIETY, being the representative provided for under (6) (*b*).

Page 64, line 12 before the sentence commencing "so" insert: "All papers intended for presentation before any meeting of the Refractories Division shall be in the hands of the Division Chairman at least ninety days before the date of the Meeting at which they are to be presented, except by written consent of the Executive Committee signed by the Division Chairman.

It shall be the duty of the Division Chairman to have his publications committee pass on and edit or reject said papers before they are preprinted. The decisions of the Refractories Division's Publications Committee shall be final, except that the right is reserved to the Publications Committee of the parent SOCIETY to decide whether or not any given paper shall be published, providing the chairman of the parent Publications Committee makes such reservations in writing to the chairman of the Refractories Division at any time before the paper in question goes to press."

Research Donald W. Ross, Chairman, gave the Annual Report of the Research Committee. The Committee has been organized to work along the following lines:

(1) Bringing to light problems which users of refractories encounter.
(2) Encouraging coöperation between workers who are conducting experiments or researches on refractory materials on processes.
(3) Endeavoring to prevent duplication of effort in this field.
(4) Endeavoring to suggest subjects for experimentation and research in this field to those who request such information.

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[1] See By-Laws, *Bull. Amer. Ceram. Soc.*, **7** [3], 62 (1928).

Several months ago a circular letter was mailed to users and manufacturers of refractory materials and to research workers using refractories or conducting investigations in connection with them, outlining the purpose of this Research Committee and urging that they use the Research Committee as a clearing house for their refractory problems. Mr. Ross reported on the replies received.

In outlining work for the present year, Mr. Ross urged that the personnel of the Research Committee and its Sub-Committees be left intact for this year, in view of the fact that the Committee is just getting under way and has not had sufficient opportunity to round out its undertakings.

The three Sub-Committees of this Research Committee made separate reports of their projects, and these reports will be published in the *Bulletin*. The Chairmen of the Sub-Committees reporting are as follows:

Sub-Committee on Fire Clay Refractories and Raw Materials (including Diaspore and Mullite), R. B. Sosman.

Sub-Committee on Silica Brick and Raw Materials, L. J. Trostel.

Sub-Committee on Magnesite and Chrome Brick and Raw Materials, J. Spotts McDowell.

FRENCH CERAMISTS OUR GUESTS

On April 8 a party of French glass and clay workers will arrive in New York to spend two weeks with us. They specified the route to be taken and time to be spent in each place. We have indicated the plants they possibly could visit on this route in the time given.

Attached is the suggested itinerary. A partial list of our French guests is also attached. They expect to have 15 or 20 in their party, about equally divided between clay and glass as stated by Jean Milhaud in his communication of February 25, as shown herewith.

The itinerary in New Jersey was arranged by George H. Brown, Secretary of the New Jersey Clayworkers Association. The French ceramists will be guests of that Association while in New Jersey. Opportunities to visit clay and glass plants in New Jersey will be negotiated by Professor Brown.

We bespeak for our French guests a hearty welcome in the States. Your assistance to this end is respectfully asked. You are being depended on for this assistance for it will take our combined efforts to equal the most gracious welcome to plants in France which has been accorded to Americans.

Confederation Generale
de la
Production Française

Paris, France, February 25

Dear Mr. Ross Purdy:

I thank you very much for your desire to occupy yourself so actively with the preparation for the visit of the French manufacturers of ceramics and glass.

Some of the French manufacturers who will be present on this trip are among those who opened their mills to the American delegates. And I thank you in advance for making this trip even more successful than the one that you made to France.

We have already twelve persons registered for this trip and I think that it can be raised to fifteen or twenty. I will let you know the names and exact occupations of each of them, but already I can point out that among the delegates of the French industry, there will be representatives of several very important companies.

I enclose the first list.

You suggested that our delegation could be accompanied by a representative of the

AMERICAN CERAMIC SOCIETY. I think it a very good plan to have a delegate of your SOCIETY as a guide for our two groups of clay and glass representatives in every city.

Some of our delegates will have the desire to make particular visits and I think the best thing would be for them to put their requests to your delegates on their arrival in New York to obtain the permissions for these particular visits.

Thanking you again and again, I remain,

Yours very truly,
(Signed) JEAN MILHAUD

Personnel of French Tour to American Potters and Glass Manufacturers

Glass Group

Paul Haviland, Directeur de la Maison Lalique; Thouvenin, Directeur de la Verrerie de Vierzon; Fournier, Ingenieur à la Verrerie de Vierzon; Godfroy-Rouillion, Directeur de la Verrerie Godfroy-Rouillion a Vierzon; Charbonneaux, Directeur de la Verrerie de Reims; Favre, Administrateur-Delegue de l'Union Verriere.

Pottery Group

Le Heron, Administrateur des Établissements Porcher; Fourmaintraux, Directeur des Établissements Ceramiques Fourmaintraux et Delassus; Édouard Fenal, Gerant de la Faiencerie de Badonviller Administrateur Delegue des Faienceries de Luneville; V. Sanson, Directeur des Établissements Sanson; Guido-Gerster, Administrateur Delegue de la Société Anonyme pour l'industrie Ceramique à Laufon (Suisse).

French Ceramic Manufacturers Tour of Eastern United States[1]

Tuesday April 8 Arrive New York: party will be met at French Line Pier and transferred by motor to Pennsylvania Hotel.

If party arrives in New York at a sufficiently early hour, a comprehensive sightseeing tour by motor coach of uptown and downtown New York will be provided. This trip will pass through the business and residential sections of the city with a stop at the Metropolitan Art Museum to permit inspection of pictures and bronzes. Return to the hotel for evening dinner. Evening free for independent action.

Wednesday April 9 The party will be transferred by motor car through the Holland Tunnel to Woodbridge, N. J., where an inspection of the Federal Seaboard Terra Cotta Co. plant and the M. D. Valentine & Bros. Co. fire brick plant will be made; continuing on to Perth Amboy, N. J., where luncheon will be provided.

After luncheon visits will be made to the National Fireproofing Co. and the General Ceramics Co. at Keasbey, N. J., where chemical stoneware is manufactured. The party will then continue on to New Brunswick, N. J., where a visit to the Ceramics Department of Rutgers University will be provided.

Evening dinner and rooms will be provided at the Woodrow Wilson Hotel.

Thursday April 10 The party will continue on to Sayreville, N. J., where a visit to the Sayre & Fisher Co. plant, manufacturing enamel, face, common, and fire brick will be made, proceeding on to the Stacy-Trent Hotel, Trenton,

[1] Travel arrangements made by Raymond and Whitcomb Co., Boston, Mass. Industrial visits and entertainment arranged by Ross C. Purdy, General Secretary, AMERICAN CERAMIC SOCIETY, Columbus, Ohio.

N. J. After luncheon, a visit to the Thos. Maddock's Sons Co. and the Scammell China Co. plants will be made.

Friday April 11

Visits will be made to the Lenox, Inc. plant manufacturing chinaware, Mitchell-Bissell Co., manufacturing porcelain specialties, and the Robertson Art Tile Co., returning to the hotel for luncheon.

After luncheon there will be visits to the Trenton Potteries Co. and the Imperial Porcelain Co. manufacturing low- and high-tension porcelains.

Leave Trenton via Pennsylvania Railroad at 5:14 P.M.

Arrive Philadelphia, Pa., Broad Street Station, at 6:00 P.M. The party will be transferred to the Benjamin Franklin Hotel.

Saturday April 12

Motor transfer provided to Broad Street Station. Leave Philadelphia via Pennsylvania Railroad at 7:20 A.M. Steel day coach accommodation and breakfast in dining car provided.

Arrive Baltimore, Md., at 9:36 A.M. Visits to the Locke Insulator Co. of the General Electric Co., Porcelain Enamel & Mfg. Co., and the General Refractories Co. will be provided; also luncheon.

Leave Baltimore via Pennsylvania Railroad at 5:31 P.M.

Arrive Washington, D. C., at 6:22 P.M. Transfer by motor car to Mayflower Hotel.

Sunday April 13

In Washington. After breakfast, a sightseeing trip by motor coach will be provided through the business and residential sections of the city, including the Mall, passing all of the public buildings of interest, the monuments, statues, embassies, legations, and notable residences, with ten-minute stop at the Lincoln Memorial.

After luncheon, a motor coach trip will be provided to Arlington National Cemetery where a visit to America's Tomb of the "Unknown Soldier" and the National Ampitheatre will be made. Return to the hotel for evening dinner.

Motor coach transfer provided to the Union Station. Leave Washington via Pennsylvania Railroad at 10:30 P.M.

Monday April 14

Arrive Pittsburgh, Pa., at 8:05 A.M. Breakfast provided in station restaurant.

Leave Pittsburgh via Pennsylvania Railroad at 9:00 A.M. Steel day coach accommodation provided.

Arrive Beaver Falls, Pa., at 9:48 A.M. Transfer by motor car to General Brodhead Hotel. Visits to the Rossman Corp. plant, manufacturing wall tile, and the Mayer China Co. will be provided.

Tuesday April 15

Motor transfer to East Liverpool, Ohio, will be provided where visits to the Homer Laughlin China Co., a large plant manufacturing semi-porcelain, and the Hall China Co. manufacturing cooking porcelain, will be made.

Transfer by motor car will be provided to Pittsburgh, arriving in time to board the sleeping car which will be open at 10:00 P.M.

Leave Pittsburgh via Pennsylvania Railroad at 11:15 P.M.

Wednesday April 16

Arrive Columbus, Ohio, 4:15 A.M. Sleeping car may be occupied until 7:30 A.M. Breakfast and luncheon will be provided at the Deshler-Wallick Hotel. Visits will be made to the AMERICAN CERAMIC SOCIETY, INC., Ceramic Departments of Ohio State University, D. A. Ebinger Sanitary Mfg. Co., Standard Pyrometric Cone Co., Federal Tile Co., manufacturing floor tile.

Banquet, Ohio State University Faculty Club.

Leave Columbus via Big Four Railroad at 11:30 P.M. Sleeping car accommodation (one-half section provided). Sleeping car may be occupied at 9:30 P.M.

Thursday April 17

Arrive Toledo, Ohio, at 5:35 A.M. Sleeping car may be occupied until 7:30 A.M. Breakfast and luncheon provided at the Commodore Perry Hotel. Visits to the Buckeye Clay Pot Co. and the Toledo Porcelain Enamel Products Co. will be provided.

Leave Toledo via Michigan Central Railroad at 6:31 P.M. Steel day coach accommodation and evening dinner in dining car will be provided.

Arrive Detroit, Mich., at 8:10 P.M. Transfer by motor car to Statler Hotel.

Friday April 18 In Detroit. After breakfast, transfer by motor coach to the Ford automobile plant at Dearborn, Mich., where will be seen the finest example of mass production of automobiles on a large scale in the world. The production of automobiles is followed in detail including the making of the nonshatterable glass which is used in all Ford automobiles.

Return to the hotel for luncheon.

In the afternoon a visit to the plant of the Champion Porcelain Co. will be provided.

Saturday April 19 In Detroit. In the morning a motor coach sight-seeing trip will be provided through the business and residential sections of the city, including Belle Isle, a beautiful park, passing the new Public Library and Museum group of buildings, returning to hotel for lunch.

Afternoon free for independent action.

Motor coach transfer provided to the dock of the Detroit and Cleveland Navigation Co.

Leave Detroit via D and C Line at 5:00 P.M. Berth in outside state room, evening dinner and breakfast provided on steamer. Over-night sail on Lake Erie.

Sunday April 20 Arrive Buffalo, N. Y. at 8:00 A.M.

Transfer by motor coach to Statler Hotel.

Trip to Niagara Falls by motor coach will be provided including complete trip around the Falls, through the Gorge of the Niagara River with stop to view the Falls, the Whirlpool, and the Rapids. This is one of the most interesting trips in the United States. Return to Buffalo for the night.

Monday April 21 In Buffalo. Visits to the Buffalo Pottery Co. and the Exolon Co. at Blasdell, N. Y., where silicon carbide for refractories and abrasives are produced, will be provided.

Leave Buffalo via New York Central Railroad at 9:00 P.M.

Tuesday April 22 Arrive New York, Grand Central Terminal, at 7:15 A.M. Motor coach transfer provided to Pennsylvania Hotel where rooms with bath and meals will be provided.

Remainder of day free for independent action.

Wednesday April 23 Motor coach transfer to French Line Pier will be provided to sail on *S. S. De Grasse* at 11:00 A.M.

French Glassware Manufacturers

Tuesday April 8 Same as for ceramic group.

Wednesday April 9 In New York. Visit to the laboratories and offices of the Glass Containers Association of America at 39 W. 38th St. and 19 W. 44th St., will be provided.

Leave New York via the Pennsylvania Railroad at 7:00 P.M.

Arrive Philadelphia, Pa., Broad Street Station at 9:00 P.M. Transfer by motor car to Benjamin Franklin Hotel.

Thursday April 10 Leave Philadelphia by motor car after breakfast for Bridgeton, N. J., where rooms will be provided at the Cumberland Hotel. After luncheon visits to the Illinois Glass Co. plant at Bridgeton and the Vineland Flint Glass Co. at Vineland, will be provided.

Friday April 11 In Vineland and Millville. Visits to the Kimball Glass Co. at Vineland, the Whitall-Tatum Co., the T. C. Wheaton Co., and the Millville Bottle Works at Millville, N. J., also the Tavern Rock Sand Co. will be provided, returning to the Benjamin Frankln Hotel, Philadelphia, for the night.

Saturday April 12

Motor transfer provided to Broad Street Station. Leave Philadelphia via Pennsylvania Railroad at 7:20 A.M. Steel day coach accommodation and breakfast in dining car.

Arrive Baltimore, Md., at 9:36 A.M. Visits to the Carr-Lowrey Glass Co., Swindell Bros. Co., and the Buck Glass Co. will be provided; also luncheon.

Leave Baltimore, via Pennsylvania Railroad, at 5:31 P.M. Arrive Washington, D. C., at 6:22 P.M. Transfer by motor car to Mayflower Hotel.

Sunday April 13

In Washington, D. C. Same as for ceramic group.

Monday April 14

Arrive Pittsburgh, Pa., at 8:05 A.M. Visits to the H. L. Dixon Co. and the U. S. Glass Co. will be provided. Breakfast and luncheon will be provided at the William Penn Hotel.

Leave Pittsburgh in the afternoon by motor car for Washington, Pa., arriving in the late afternoon. Rooms will be provided at the George Washington Hotel.

Tuesday April 15

In Washington, Pa. Visits to the plants of the Simplex Engineering Co., the Hazel-Atlas Co., and the Findlay Clay Products Co. will be provided returning to Pittsburgh in time to board the sleeping car, leaving Pittsburgh via Pennsylvania Railroad at 11:15 P.M. Sleeping car open for occupancy at 10:00 P.M.

Wednesday April 16

Arrive Columbus, Ohio, at 4:15 A.M. Sleeping car may be occupied until 7:30 A.M. Breakfast, luncheon, and dinner will be provided at the Deshler-Wallick Hotel.

Visits will be made to the AMERICAN CERAMIC SOCIETY, INC., Ceramic Depts. of Ohio State University, Standard Pyrometric Cone Co., Federal Glass Co., Miller Machine & Mould Works, making glasshouse machinery, Buckeye Window Glass Co., and the Berney-Bond Glass Co.

Leave Columbus via Big Four Railroad at 11:30 P.M. Sleeping car may be occupied at 9:30 P.M.

Thursday April 17

Arrive Toledo, Ohio, at 5:35 A.M. Sleeping car may be occupied until 7:30 A.M. Breakfast and luncheon provided at the Commodore Perry Hotel.

Visits to the Libbey Glass Mfg. Co., Libbey-Owen Sheet Glass Co., Buckeye Clay Pot Co., and the Toledo Mould Co. will be provided.

Leave Toledo via Michigan Central Railroad at 6:31 P.M. Steel day coach accommodation and evening dinner in dining car will be provided. Arrive Detroit, Mich., 8:10 P.M. Transfer by motor car to Statler Hotel.

Friday April 18

In Detroit. After breakfast, transfer by motor coach to the Ford automobile plant at Dearborn, Mich. Return to hotel for luncheon. Afternoon free for independent action.

Saturday April 19

In Detroit. Same as for ceramic group.

Sunday April 20

Arrive Buffalo, N. Y., at 8:00 A.M. Same as for ceramic group.

Monday April 21

After breakfast motor car transfer provided to Delaware, Lackawanna & Western Railroad Station. Leave Buffalo via D. L. & W. Railroad at 9:30 A.M. Steel day coach accommodation and luncheon in dining car. Arrive Corning, N. Y., at 12:21 P.M. Transfer by motor car to Baron Steuben Hotel where rooms with bath and meals will be provided. Visit to the Corning Glass Works, Steuben Division.

Tuesday April 22

Leave Corning via D. L. & W. R. R. at 12:21 P.M.

Steel day coach accommodation, luncheon and evening dinner provided in dining car.

Arrive Hoboken, N. J., at 7:12 P.M. Leave Hoboken by Hudson Tunnel.

Arrive New York, 33rd Street and Broadway Station, at 7:28 P.M. Transfer by motor car to Pennsylvania Hotel.

Wednesday April 23 Same as for ceramic group.

LOCAL SECTION NEWS

Michigan-Northwestern Ohio Section[1]

The Michigan-Northwestern Ohio Section of the AMERICAN CERAMIC SOCIETY held a meeting on February 25, at the Cadillac Athletic Club, Detroit, Mich. T. S. Curtis was the guest speaker, talking on "Fundamentals of Mullite Development." Supplementing his talk were shown motion pictures and lantern slides illustrating the development of mullite crystals and the effect of mullite in ceramic materials.

The dinner was attended by forty-nine and the lecture by seventy-five persons. A great deal of interest was shown and a lively discussion followed Mr. Curtis' most interesting paper.

NEW MEMBERS RECEIVED FROM FEBRUARY 1 TO MARCH 1

PERSONAL

A. T. Alexander, P. O. Box 2280, Montreal, Canada.
John Albert Andrews, 2237 Grandin Rd., Cincinnati, Ohio; Newport Rolling Mill Co., Newport, Ky.
Mark S. Bailey, Ceramic Engineer, Harrop Ceramic Service Co., 310 West Broad St., Columbus, Ohio.
Herbert C. Beasley, Factory Manager, Ingram-Richardson Corp., Bayonne, N. J.
J. Russell Britt, 2509 Texas Ave., St. Louis, Mo.; Supt. of Tile Plant, Superior Enamel Products Co.
Robert M. Campbell, 25 Hanford Place, Trenton, N. J.; Pottery Supt., J. L. Mott Co., Inc.
Kenneth P. Corson, Ceramic Engineer, Gladding, McBean & Co., Taylor, Wash.
Samuel Edwin Eldridge, Kemper Lane Apt. Hotel, Cincinnati, Ohio; Newport Rolling Mill Co., Newport, Ky.
Edwin W. Esslinger, 2205 Cleneau Ave., Norwood, Ohio; Supervisor Industrial Gas Division, Union Gas and Electric Co., 4th and Main Sts., Cincinnati, Ohio.
Howard Farkas, 50 Church St., New York, N. Y.; Vice-President, U. S. Stoneware Co.
Edward Hartford, 711 Euclid Ave., Toronto, Ohio; Mechanical Engineer, Toronto Foundry & Machine Co.
W. V. Hollingsworth, American Encaustic Tiling Co., Zanesville, Ohio.
S. A. van Hoytema, Mechanische Technologie, Nieuwelaan 76, Delft, Holland.
Frank L. Jones, Mellon Institute, Pittsburgh, Pa.
Frank H. Kohne, 819 Twelfth St., New Brighton, Pa.; Ceramic Color and Chemical Mfg. Co.
George Little, 71 South St., Somerville, N. J.; Junior Ceramist, Johns-Manville, Inc., Manville, N. J.
Juan Maiza, c/o Crist. Rigolleau, Berazategui, F. C. S., Argentina.
Wesley G. Martin, Research Chemist, A. O. Smith Corp., Milwaukee, Wis.
Ernst A. Meyerhofer, Meyerhofer & Co., 19 Loewenstrasse, Zurich, Germany.
W. J. Miller, 7337 Schoyer Ave., Swissvale, Pa.; President, Miller Glass Engineering Co., Vice-President, W. J. Miller, Inc.
Willard J. Parker, 7 East 44th St., New York, N. Y.; Commissioner, Feldspar Grinders' Institute.
Gerald E. Reinker, Ceramic Engineer, Incandescent Lamp Dept., General Electric Co., 1133 East 152nd St., Cleveland, Ohio.
Foster T. Rhodes, 205 Fay Rd., Syracuse, N. Y.; Foreman, Onondaga Pottery Co.

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[1] E. B. Flu, *Secretary.*

Everett Haddon Shands, Box 5626, College Sta., Raleigh, N. C.; Instructor in Mechanical Engineering, North Carolina State College.
Paul F. Udinson, Strastnoj Boulevard N. 13, Moscow, U. S. S. R.; Mendelief's Chem.-Technological High School.
Louis Vielhaber, Nahestr. 26, Duisburg, Germany; Publisher of *Emaillewaren-Industrie.*
William D. Waltman, 551 Fifth Ave., New York, N. Y.; President, Isolantite Co. of America.
Charles Douglas Woodhouse, P. O. Box 117, Laws, Inyo County, Calif.; General Manager, Champion Sillimanite, Inc.

STUDENT

Don J. Cavanaugh, Pennsylvania State College, State College, Pa.
Earl Robert Davey, University of Toronto, Toronto, Canada.
J. D. Hammock, University of Washington, Seattle, Wash.
John B. Miller, University of Illinois, Urbana, Ill.
Alice E. Pembroke, Mechanics Institute, Rochester, N. Y.

Membership Workers' Record

PERSONAL		STUDENT	
R. S. Bicknell	1	A. I. Andrews	1
P. P. Budnikoff	1	George J. Bair	1
H. T. Coss	1	R. J. Montgomery	1
A. F. Greaves-Walker	1	Hewitt Wilson	1
Frank M. Hartford	2	Office	1
F. G. Jaeger	1		–
L. H. Minton	1	Total	5
F. H. Riddle	1	Grand Total	32
C. D. Spencer	1		
Karl Turk	1		
W. F. Wenning	1		
Office	15		
	—		
Total	27		

ROSTER CHANGES IN FEBRUARY

CORPORATION*

Harshaw Chemical Co., J. L. Walsh (voter), Harshaw Bldg., 1945 E. 97th St., Cleveland, Ohio. (D. T. Penny (voter), 1610 Hanna Bldg.)
Mueller Company, J. R. Mayhew (voter), Decatur, Ill. (A. V. Lawton (voter).)

PERSONAL*

Alderson, Benjamin, Research and Development Dept., Owens-Illinois Glass Co., Alton, Ill. (The American Bottle Co., Streator, Ill.)
Arnold, Howard C., 1131 Foulkrod St., Philadelphia, Pa. (Box 323, Momence, Ill.)
Arnold, Thomas M., Wheatley Tile & Pottery Co., P. O. Box 836, Cincinnati, Ohio. (Membership transferred from Harry J. Macke.)
Brosius, J. P., Supervisor Heavy Industrial Gas Sales, Equitable Gas Co., 435 Sixth Ave., Pittsburgh, Pa. (Membership transferred from F. B. Jones.)
Compton, Max D., Box 603, Lincoln, Calif. (183 Crutcher Ct., Auburn, Calif.)
Crandall, James R., 325 Pitt St., Wilkensburg, Pa.; Crown Chemical Co. (212 E. 2nd St., Elyria, Ohio.)
Drew, Charles H., C. Drew & Co., Kingston, Mass. (Membership transferred from W. D. Ford.)
Fackt, Geo. P., Gladding, McBean & Co., 621 S. Hope St., Los Angeles, Calif. (2525 Clybourn Ave., Chicago, Ill.)
Hoffman, George E., Crane Co., Chicago, Ill. (Trenton Potteries Co., Trenton, N. J.)
Humphrey, Ingraham, Lima, N. Y. (Central Y. M. C. A., East Liverpool, Ohio.)

[1] Addresses within the parentheses ( ) represent the old address.

Jones, C. L., 52 Vanderbilt Ave., New York, N. Y. (610 Sale Ave., Elizabeth, N. J.)
Kennaday, Clinton R., 32 Graham Ave., Metuchen, N. J. (44 Green St., Woodbridge, N. J.)
Kirk, H. S., 47 Berwyn St., Orange, N. J. (Universal Sanitary Mfg. Co., New Castle, Pa.)
Loomis, Geo. A., Engineering Experiment Sta., Ohio State University, Columbus, Ohio. (218 Thirteenth St., N. E., Mason City, Iowa.)
McCaughna, A. D., Leonard Refrigerator Co.,, Grand Rapids, Mich. (Membership transferred from Kelvinator Corp., Detroit, Mich.)
Murphy, J. L., Nelsonville Brick Co., 150 East Broad St., Columbus, Ohio. (Hocking Valley Brick Co., Nelsonville, Ohio.)
Potter, William A., Secy.-Treas., Mojave Clay Corp., Mojave, Kern County, Calif. (Manager, Pacific Porcelain Ware Co.)
Pressler, E. E., 501 N. Central Ave., Chicago, Ill.; Chicago Vitreous Enamel Product Co. (Erwin Feldspar Co., Erwin, Tenn.)
Rees, W. J., Department of Applied Science, University of Sheffield, St. George's Square, Sheffield, England. (102 Ivy Park Road.)
Russel, John W., Marietta Hollow Ware & Enameling Co., Marietta, Pa. (522 Chestnut St., Columbia, Pa.)
Titsworth, Adeline, 327½ N. Vermont Ave., Los Angeles, Calif. (Sonyea, N. Y.)

STUDENT*

Harvey, Edwin T., Y. M. C. A., Joliet, Ill. (606 West 11th St., Rolla, Mo.)
Ladd, E. J., Box 21, Georgia School of Technology, Atlanta, Ga. (Fort Payne, Ala.)

These roster changes which are published each month may be checked against the complete Membership Roster which was published in the July, 1929, issue of the *Bulletin*. Copies of this issue may be obtained from the Secretary's office, price $2.00.

NOTES AND NEWS

NEWS FROM THE CERAMIC SCHOOLS

New York State School of Clayworking and Ceramics[1]

Ceramic Alumni Association Formed

On Monday evening, Feb. 17, at the 32nd Annual Meeting of the AMERICAN CERAMIC SOCIETY at the Royal York in Toronto, a group of sixty alumni, professors, and students of Alfred University held its annual Alfred dinner. One of the purposes of the meeting was to form an Alumni Association of graduates of the New York State School of Clayworking and Ceramics which should establish contact between alumni and undergraduates.

C. Forrest Teft officiated as toastmaster. The first speaker, G. A. Bole, talked on "Service." He was followed by Professor Binns whose topic was "Reminiscences." These took the form of anecdotes of former students and occurrences in the ceramic school at Alfred. The next speaker was Robert Bassett, one of the Alfred seniors. He told of the Alfred Student Branch of the AMERICAN CERAMIC SOCIETY, what it was doing and what it needed.

The outcome of the meeting was the formation of an Alfred Ceramic Alumni Association which should bring about a closer relationship between the alumni and the students. It will provide speakers for the Student Ceramic Society meetings, and discuss actual problems and conditions in various plants, thus keeping the students in touch with the practical application of all they learn in classes.

* Addresses within the parentheses ( ) represent the old address.

[1] Ernest H. Spencer.

The officers of the new Alumni Society are John McMahon, *President;* Robert Sherwood, *Vice-President;* Louis Collin, *Secretary and Treasurer.*

The following faculty members of the ceramic school attended the Meeting in Toronto: Director Binns, Professors Rice, Amberg, Merritt, and Harder, and Miss Ruth Dare Whitford.

The students attending the Toronto meeting were Robert Bassett, John Gallup, Karl Smith, John Thomson, Delos Walmsley, Albert Titsworth, Luke Beckerman, Ferne Green, Frances Green, Dorothy Hallock, Mary Brown Allen, Harriet Mills, Roberta Leber, Virginia Wallm, and Paulina Martin.

The New York Chapter of Beta Pi Kappa initiated Professor J. B. Shaw, Director of the Penn State Ceramics School, into honorary membership in the SOCIETY, Wednesday evening, Feb. 19, at the Toronto Meeting.

At a meeting of the Student Branch of the AMERICAN CERAMIC SOCIETY held Feb. 25, Karl Smith and John Gallup presented a report of the Toronto Meeting.

Iowa State College[1]

Cox Presents Paper before A.A.A.S.

Paul E. Cox, head of the Department of Ceramic Engineering, read a paper before the meeting of the American Association for the Advancement of Science which was recently held in Des Moines. Professor Cox's paper considered mainly the possibilities of future ceramic development and manufacture in Iowa, emphasizing three main points: (1) Large amounts of shales and No. 2 fire clays are found all over the state giving a source of cheap raw material. (2) Although some raw material would have to be imported for the manufacture of whiteware, this could not be considered a handicap, as all plants of this nature import raw materials. Iowa, being primarily an agricultural state, has a large amount of cheap labor which could be profitably diverted into manufacturing. (3) Iowa is ideally located for distribution to all parts of that great consuming portion of the U. S. for manufactured products, the Middle West.

New Course in Decorative Ceramics

Professor Cox announces that a 4-year course in decorative ceramics will be offered at Iowa State College next year for the first time. At the present time there are two major schools in the U.S. offering courses of this nature. The policy to be used at Iowa State College differs somewhat from that used in these other schools in that fine arts will not be considered essential.

This course will be almost entirely technical, but enough freehand drawing and designing will be included to acquaint the student with the rudiments of artistic design. Mechanical methods of pottery decoration, glass, and other products of ceramic industries will be included, and lithography and engraving processes, production of ceramic colors, shape design, and special glazes will be emphasized in the course.

The new course will train students to do work which in the past has been done only by workers brought from Europe. It is intended for the person who has ability in coloring and designing, and is so planned as to give a complete picture of the making and decorating of ceramic products. There is a keen need for people with the sort of training that they will receive here, to go into decorating shops and potteries.

Booklet on Ceramics

Iowa State College is publishing a booklet on ceramics edited by Professor Cox, which will be sent to all the high schools in the state. It outlines the ceramic course of study at Iowa State College, and mentions the opportunities offered to graduates. Illustrations are included of the faculty, laboratories, kiln room, and other equipment.

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[1] Glenn W. Johnson.

Activities of Students

Frank B. Hodgdon, in addition to his regular college work, is working as a laboratory assistant in the geology department.

George Petersen, a senior student, has developed a new method for manufacture of blue glazes. Petersen's research has revealed that by adding comparatively large amounts of barium carbonate to the commonly used copper glaze, a turquoise blue much desired as a tile finish can be secured. A paper on this laboratory research, written by Petersen, was presented at the Annual Meeting of the AMERICAN CERAMIC SOCIETY.

Dan Cherry is conducting a research study in the manufacture of ruby glass. At present all ruby glass is manufactured by additions of selenium to the glass batch. When melted, 75% of the selenium is usually vaporized. It is hoped to eliminate this loss by additions of selenium to the melted glass batch in just enough proportion to saturate the melted mass and yet not waste any. The manufacture of the complicated retorts and crucibles that are necessary has added to the problem.

Gerald L. Johnson, junior ceramic engineering student, has been elected circulation manager of the *Iowa Engineer*. The *Iowa Engineer* is a member of Engineering College Magazines, Associated, and as such occupies an important place in its field.

Carroll Garland, a graduate of the Fall Quarter is handling the firing of the railroad continuous kiln at the plant of the A. P. Green Fire Brick Company, Mexico, Mo.

OUR REPRESENTATION AT JOSIAH WEDGWOOD BICENTENNIAL[1]

The week of May 18 is the time; Stoke-on-Trent the place. The American representatives will be

General and Mrs. Edward Orton
Karl Langenbeck
Mr. and Mrs. D. W. Scammell (New Jersey Clay Workers Assn.)
Mr. and Mrs. B. E. Salisbury, Mr. and Mrs. W. E. Wells (U. S. Potters Assn.)
R. W. Wainford (Feldspar Grinders Institute)
A. V. Bleininger
R. H. Pass
F. H. Rhead
C. M. Franzheim
Prof. and Mrs. R. M. King
Dr. and Mrs. W. G. France

If you can go may we suggest that you secure hotel accommodations through Dr. W. J. Mellor, Stoke-on-Trent, England, and steamship arrangements through F. M. Teraberry, Thos. Cook & Son Co., 585 Fifth Ave., New York, N. Y.

The bicentenary of Josiah Wedgwood, "the father of English pottery," will be marked by celebrations on an international scale from May 18 to 24. There will be a Wedgwood week in Stoke-on-Trent, followed by one in London, and a special exhibition of Wedgwood ware will be held in Paris, in New York, and probably in other cities. Many members of the AMERICAN CERAMIC SOCIETY plan to go to Stoke-on-Trent and take part in the festivities. There is to be a pageant and military tattoo, and a display of modern pottery. The Queen has consented to be patroness of the historical exhibition which will be opened in the Five Towns, and it is hoped that the Prince of Wales will attend the pageant. Many Wedgwood objects from the Royal

[1] For program see *Bull. Amer. Ceram. Soc.*, 9 [3], 81–85 (1930).

collection will probably be on view. The Archbishop of Canterbury will attend the religious service for the opening of the celebrations, and the Archbishop of York will probably be present at the concluding service. The pageant and tattoo are being organized on a scale worthy of the fact that Wedgwood's age was an age of great soldiers, great statesmen, great writers, great poets. It was a period rich in literary achievements, and particularly in the realm of poetry, to which, surely, pottery is closely allied.

Stoke-on-Trent is one of the great workshops of England, famous for many generations as the chief center of pottery manufacture, both in its artistic and utilitarian branches. It has other important industries also, but pottery is supreme beyond challenge. But in one respect Stoke-on-Trent at the present day does not live up to its reputation. In the popular imagination the Potteries have been known as the smoky "Potteries," and it is still possible to buy ingeniously faked picture post cards showing great volumes of dense black smoke belching forth from innumerable chimneys. But the reality is very different, and a great disappointment to amateur photographers anxious to "snap" impressive smoke-effects. The tradition, although it had some foundation in fact, was always grossly exaggerated, and modern scientific means of smoke abatement have made it farther from the truth than ever.

During the past decade many improvements and developments have taken place in the industrial arts generally of England, but in no industry is the advance so greatly marked as in the manufacture of pottery and porcelain in the great federated town of Stoke-on-Trent, which comprises Tunstall, Burslem, Hanley, Stoke-on-Trent, Fenton, and Longton.—*The American Traveler's Gazette*

The Passion Play at Oberammergau

Throughout the spring and summer, the world famous Passion Play will be performed in the charming Bavarian Village of Oberammergau and no one attending the Josiah Wedgwood Bicentennial will want to miss the opportunity to witness this magnificent spectacle.

The Thos. Cook & Sons Co. will secure admission tickets and housing accommodations.

The dates of presentation are May 11, 18, and 25, June 1, 9, 15, 22, and 29, July 2, 6, 9, 13, 16, 20, 23, 27, and 30.

CALENDAR OF CONVENTIONS

Organization	Date	Place
American Assn. for the Advancement of Science	December 29, 1930 to January 3, 1931	Cleveland, Ohio
AMERICAN CERAMIC SOCIETY	February 22–27, 1931	Cleveland, Ohio
American Chemical Society	April 8–12, 1930	Atlanta, Ga.
American Concrete Institute	February, 1931	Milwaukee, Wis.
American Electrochemical Society	May 29–31	St. Louis, Mo.
	September 25–27, 1930	Detroit, Mich.
American Foundrymen's Assn.	May 12–16, 1930	Cleveland, Ohio
American Gas Assn.	October 13–17, 1930	Atlantic City, N. J.
American Institute of Chemical Engineers	June 4–6, 1930	Detroit, Mich.
American Mining Congress		
Annual Convention of Practical Coal Operating Men and National Exposition of Coal Mine Equipment	May 5–9, 1930	Cincinnati, Ohio
Western Division Meeting	October 13–18, 1930	El Paso, Texas
Annual Convention	December 1–6, 1930	Washington, D. C.
American Refractories Institute	May 19–20, 1930	White Sulphur Springs, W. Va.

American Society of Mechanical Engineers		
Fiftieth Anniversary Meeting	April 5–9, 1930	New York, N. Y., and Washington, D. C.
Semi-Annual Meeting	June 9–12, 1930	Detroit, Mich.
American Society for Steel Treating	September 22–27, 1930	Chicago, Ill.
American Society for Testing Materials	June 23–27, 1930	Atlantic City, N. J.
Assn. of Scientific Apparatus Makers of the U.S.	May, 1930	Atlantic City, N. J.
National Academy of Sciences	April 28–30, 1930	Washington, D. C.
National Assn. of Manufacturers of Heating and Cooking Appliances	May 14–15, 1930	New York, N. Y.
National Electrical Exposition	October 6–11, 1930	New York, N. Y.
National Exposition of Power and Mechanical Engineering	December 1–6, 1930	New York, N. Y.
National Glass Distributors Assn.	December 2–4, 1930	Pittsburgh, Pa.
National Safety Council	September 29 to October 4, 1930	Pittsburgh, Pa.
New Jersey Clay Workers Assn.	June, 1930	Asbury Park, N. J.
Ohio Ceramic Industries Assn.	May 16–17, 1930	Columbus, Ohio
Taylor Society	May 1 and 2, 1930	Columbus, Ohio
	December 3–5, 1930	New York, N. Y.
Tile and Mantel Contractors' Assn. of America	April 8–12, 1930	New Orleans, La.

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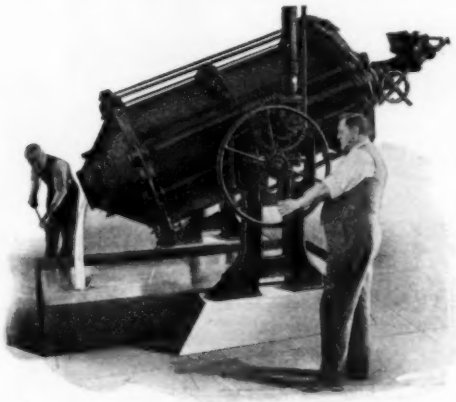

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C

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Roessler and Hasslacher Chemical Co.
United Clay Mines Corp.

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Kentucky-Tennessee Clay Co.
Old Hickory Clay and Talc Co.
Spinks Clay Co., H. C.
United Clay Mines Corp.

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Kentucky-Tennessee Clay Co.
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Roessler & Hasslacher Chemical Co.
United Clay Mines Corp.
Vitro Mfg. Co.

Clay (Fire)
Corundite Refractories Co.
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Golding Sons Co.
Harbison-Walker Refractories Co.
Kentucky-Tennessee Clay Co.
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Clay (German Vallendar)
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Clay (Potters)
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Golding Sons Co.
Hammill & Gillespie, Inc.
Harshaw Chemical Co.
Pennsylvania Pulverizing Co.
Roessler and Hasslacher Chemical Co.

Cornwall Stone (Imported)
Golding Sons Company
Harshaw Chemical Co.

Crucibles (Filter, Melting, Ignition)
Norton Co.
Potters Supply Co.

Crushers
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Cryolite
Harshaw Chemical Co.
Roessler & Hasslacher Chemical Co.

D

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Harshaw Chemical Co.
Roessler and Hasslacher Chemical Co.
Vitro Mfg. Co.

Dishes (Alundum, Filtering, Ignition)
Norton Co.

Disintegrators
Chambers Brothers Co.
Mueller Machine Co., Inc.

Disks (Alundum, Porous, Filter)
Norton Co.

Dolomite
Harshaw Chemical Co.

Driers
Harrop Ceramic Service Co.

Driers (China Ware, Porcelain)
Philadelphia Drying Machinery Co.
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Drying Machinery
Philadelphia Drying Machinery Co.
Proctor & Schwartz, Inc.

E

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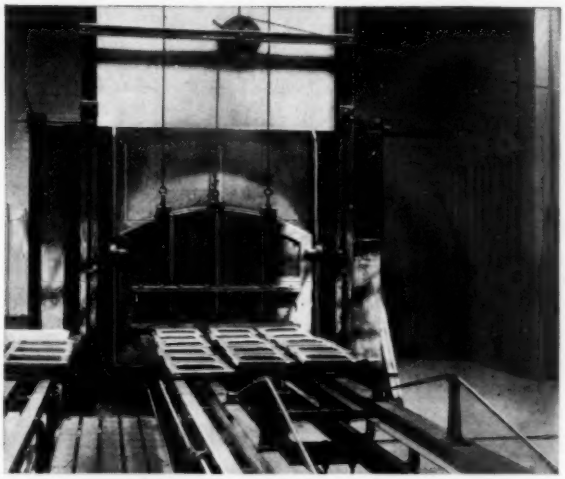

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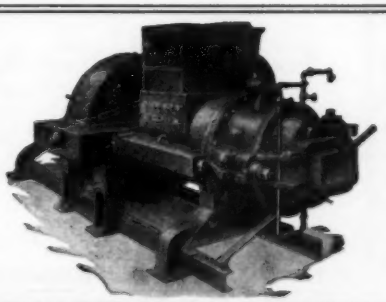

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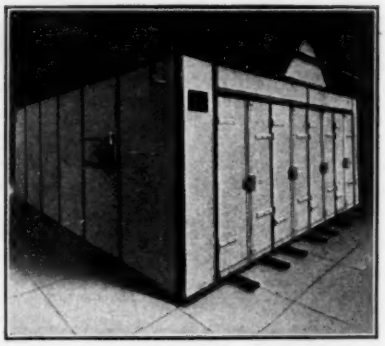

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